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U. S. STEEL SHEATHED PROTECTED CRUISER ALBANY, BUILT AT ELSWICK.

On this page we present a reproduction of an instantaneous photograph of the U. S. cruiser *Albany*, taken while on her trial trip in British waters recently. This vessel, as our readers are no doubt aware, is a sister ship to the U. S. S. *New Orleans*, both vessels having been purchased in England shortly before the breaking out of the Spanish-American war. The *Albany* was constructed at the Elswick yard of Armstrong, Whitworth & Co., Newcastle-on-Tyne, under the supervision of Assistant Naval Constructor H. G. Gillmor, U. S. N.

U. S. S. ALBANY, 3,700 TONS, DOING 20 KNOTS ON HER TRIAL TRIP.

The speed trials of the *Albany* were carried out January 9 and 11 last, Lieut.-Com. J. C. Colwell, U. S. N., the naval attaché in London, representing the U. S. Government. On the first day's trial there was a stiff breeze, and on the second day a heavy swell was encountered. An average of about 20 knots was the result of the trials, and Lieutenant-Commander Colwell reported his belief that the vessel could have shown 21 knots maximum if needed, as on the full power trial the engines worked easily and the boilers were blowing off during the greater part of the run. Lieut. Com. G. F. W. Holmes, U. S. N., accompanied by other naval officers and men, has gone to England in the U. S. S. *Prairie* to bring home the *Albany*.

Originally both the *New Orleans* and *Albany* were laid down at Elswick for the Brazilian Navy, and indeed the *New Orleans* was ready for sea and flying the

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Brazilian flag when re-commissioned as an American war vessel in March, 1898. As war with Spain was then impending the *New Orleans* was brought across the Atlantic with as little delay as possible, the crew being furnished by the U. S. S *San Francisco* then on the European station. For this reason no changes were made in the accommodations on the *New Orleans* and she was not an ideally comfortable vessel for North Atlantic service. There was no heating system on board, the quarters were very cramped, and such inconveniences as the marking of all gear in the Portuguese language were numerous. As work on the *Albany* had not far advanced, and there was no possibility of delivery during the Spanish war, there was opportunity to adapt the vessel to our service. Various minor alterations were therefore carried out on this vessel under the direction of the Naval Bureaus at Washington. In the case of the *New Orleans* also complaints were made as to her stability and this led to a series of inclining experiments, carried out at the Brooklyn Navy Yard some time ago. These experiments showed that while the vessel was tender she was perfectly safe under normal conditions, and no fears are entertained now for the safety of either or both vessels.

The U. S. S. *Albany* is classed as a steel sheathed protected cruiser, and is of these dimensions: Length, 346 ft.; beam ,43 ft. 9 in.; mean draft, 18 ft.; displacement, 3,769 tons. She is fitted with twin screws, driven by triple expansion engines of 7,500 I. H. P., and has a normal coal capacity of 500 tons. She is armed with six 6-in. and four 4.7-in. (British caliber) rapid fire guns in her main battery, and ten 6-pounder and eight 1-pounder rapid fire guns and two automatic guns in her secondary battery. She has also three torpedo tubes. Her protective deck is of a maximum thickness of 3 in., and armor of 4.5 in. thick affords protection on the gun positions. The *Albany* was launched January 14, 1899.

S. S. Kaiserin Maria Theresia.—When the North German Lloyd S. S. *Kaiserin Maria Theresia* reached New York last month on her westward trip, few would have recognized in the magnificent liner the old familiar *Spree*, so great a metamorphosis had she undergone. The new vessel is indeed a remarkable example of the present day possibilities in vessel construction. The practically new vessel is of these dimensions: Length, 546 ft.; beam, 52 ft.; depth, 37 ft.; gross tonnage, 7,800 tons. She has accommodations for 330 first cabin, 140 second cabin and 400 steerage passengers, and carries besides a crew of 290 all told. The twin screws are driven by triple expansion engines of 17,000 I. H. P., which are expected to give a sustained speed of 20 knots. The engines have cylinders, 43 1-2 in., 67 in. and (2) 77 in. dia. by 63 in. stroke. All shafting in the vessel is of nickel steel and the propellers are of bronze. They are three bladed and are 18 ft. 4 1-2 in. dia. In addition to the main engines there are 38 auxiliary engines with a total of 66 steam cylinders. Steam is generated in nine double ended boilers, 15 ft. 4 in. dia. and 18 ft. 7 in. long, and four single ended boilers of the same diameter, and 10 ft. 3 in. long. In the passenger quarters the decorations and furnishings are unusually magnificent. In exterior appearance the vessel has a fine appearance in the water.

ON THE LAUNCH OF A BRITISH BATTLESHIP FROM A GOVERNMENT DOCKYARD.*

BY H. R. CHAMPNESS, CHIEF CONSTRUCTOR, R. N.

INTRODUCTORY.

The author offers some remarks on this subject partly upon the suggestion of the president, and also because the members of the institution will naturally be interested in what was a considerable feat in engineering, and, at the same time, a striking development of the resources of the port in which the summer meeting is being held. The launch was that of Devonport's first modern battleship, H. M. S. *Ocean*,† the first since the days of wood shipbuilding, the preceding ship having also been named *Ocean*, and launched as long ago as 1863. How great the advance was will be understood from the fact that the weight of the present ship as launched was 7,110 tons, the nearest approach to this being a steel cruiser, whose launching displacement was 2,830 tons, sent off the same slip in November, 1890. When it is remembered that a very few years since the opinion was seriously expressed that battleships could not be built at Devonport, while, during the last twelve months, three such ships have been upon the blocks, two of which are now afloat, the third well advanced for launching, and a fourth soon to be laid down, it will be admitted that the development promises to be permanent. (See Fig. 1, H. M. S. *Ocean*.)

It is true that this is not a record weight even for battleships launched from the Imperial Dockyards, and it has been far eclipsed by what was lately done in launching the steamship *Oceanic*, when 11,000 tons slid into the water, though the mean pressure per square foot of the cradle was only 2.35 tons, as compared with the 2.5 tons of the *Ocean*; but those most closely responsible for ship launching have little desire to create records of this sort, and certainly, so far as the chief constructors of the Naval Dockyard are concerned, the builders of the *Oceanic* are welcome to their pre-eminence.

BUILDING SLIPS.

An incidental evidence of the growth in dimensions of modern ships is seen in some of the naval yards, where the building slip has been adapted for launching the present ships of great beam and flat floor by cutting away the sides of the slip at the lower end to enable the full section of the ship to clear it. This was avoided at Devonport by increasing the width of the slip throughout sufficiently to provide for all probable increases of beam; the slip was also lengthened at the upper end, and two concrete piers 25 ft. wide were built at the lower end in wake of the launching ways, to carry the ship into deep water when the fore end of the cradle

*A paper read before the Institution of Mechanical Engineers, England.

†Since this article was written H. M. S. *Ocean* has been placed in commission on the Mediterranean station. She is a vessel of 12,950 tons displacement, of these dimensions: Length, 390 ft.; beam, 74 ft.; draft, 25 ft. 5 in. She is fitted with twin screws, driven by triple expansion engines of 13,500 collective horse power. Steam is supplied by Belleville water-tube boilers. Her armor is Harveyized steel, ranging in thickness from 12 in. downward, and her armament includes four 12-in. breech loaders, twelve 6-in. rapid firers, and many smaller guns. She has also five torpedo tubes, four of which are submerged. Her trial speed was in excess of 18 knots.

left the groundways. How well these old slips were piled is clear, since, in spite of the enormous increase of weight borne beyond what could have been dreamed of when they were first prepared, no sign of subsidence of any kind was discernible, though periodical tests for it were made, and the structure was carefully watched.

BUILDING DECLIVITY.

The declivity of the keel in building was 5-8 in. to the foot, and about as usual for a ship of this size, and that of the groundways, or foundation on which the cradle carrying the ship slides, was 51-64 in. to the foot. The longitudinal section of this surface was a circular arc, and had a "camber," or round up, of 9 in. in a length of 300 ft. This prevented the groundways becoming hollow under compression due to the weight of the ship and cradle, and so increasing the difficulty of launching, though there is, perhaps, no absolute necessity for this in naval yards where the floor of the slip is of granite or other hard stone upon a thick bed of concrete. It is, however, desirable that the form of the groundways should have some effect in holding the ship just before launching, and this varies with the position decided on for the top of the camber. Dockyard practice in this respect differs, and this point is sometimes at mid length, and in other cases at two-thirds the length of ship from the bow, or even at the after perpendicular. The declivity of 51-64 in. to the foot, referred to above, is the gradient of the tangent to this curved surface at the top of the camber, and the holding tendency is greatest the farther aft the tangent point is. In the *Ocean* this point was at the aft side of stern post or after perpendicular. In launching, the fore end of the straight part of the keel approaches the bottom of the slip in each foot of movement approximately by the difference between the launching and building declivities, viz.,

$$\frac{51}{64} - \frac{5}{8} \text{ or } \frac{11}{64} \text{ in.}$$

and as the distance from the fore end of the keel to the after end of the straight floor of the slip was 348 ft., this drop of the keel was 11-64 in. × 348, or 5 ft. This consideration, and the clearance between the keel and the bottom of the slip at this point, generally from 1 ft. to 2 ft., determines the height at which the foremost block shall be laid for building, and taken in connection with the building declivity, enables the blocks to be laid correctly, in view of the launching conditions. It is further necessary that this height of blocks should be sufficient to allow room on top of the groundways for the section of cradle shown in Fig. 15, including the bilgeway, the wedges or "slices," and the solid timber between them and the slip which is known as "stopping up," and had a minimum depth of about 6 in. The length of the groundways must be such as to secure that the ship and cradle shall not tip about their after end, and to determine this certain calculations were necessary, the results of which are shown in Fig. 2.

CALCULATION OF SHIP'S LAUNCHING WEIGHT.

The approximate date of the proposed launch determined the time the ship would be upon the slip, and the local circumstances as to available labor, coupled with building experience, enabled an approximation of the launching weight to be made. The proper progress of the ship fixed the parts which made up this weight, and thus it was possible to calculate in detail the weight of the several parts, and the positions of their centers of gravity. The weight calculation is much simplified when, as is usual, a record is kept of all weights put on board. The total weight, and the position of center of gravity both vertically and horizontally, were thus obtained, and were easily corrected as the actual date of launch approached, and a closer approximation to the launching weight became possible. The probable height of tide was given by the tide tables, and was drawn upon the profile of the ship as she lay on the blocks (Fig. 3). The displacement was calculated to lines parallel to this at any convenient distance, say 2 ft., which, as the ship was launched at a declivity of 51-64 in. to the foot, corresponded to a travel down the ways of $\frac{2 \times 12 \times 64}{51}$, or about 30 ft., and this is the distance apart of the cal-

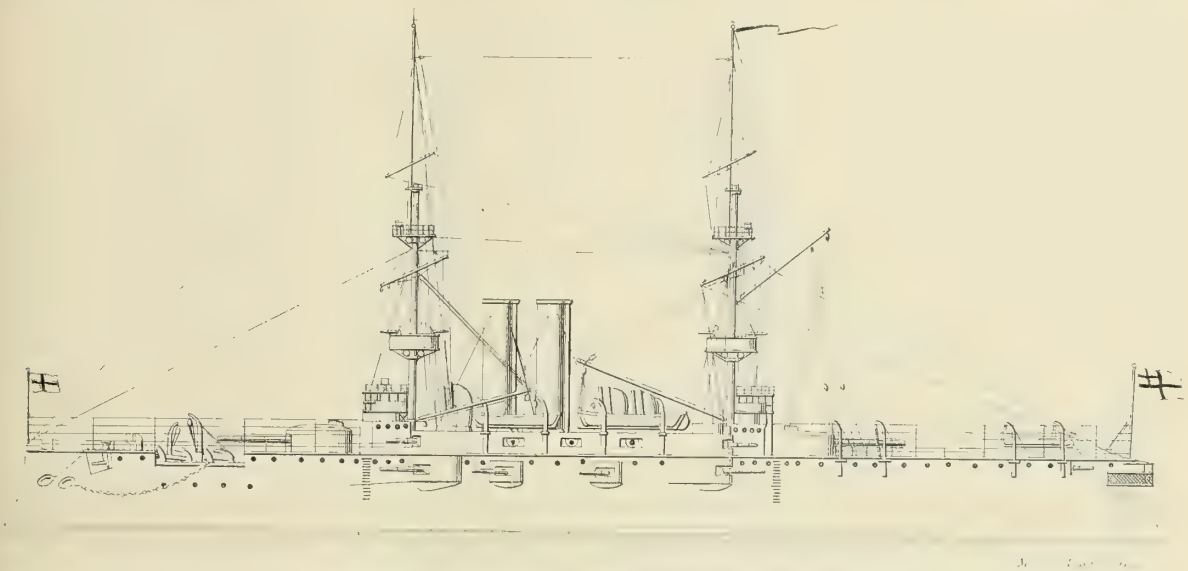


FIG. 1.—H. M. S. OCEAN. BUILT AT DEVENPORT DOCKYARD.

culated ordinates giving the curve of buoyancy (Fig. 2). The position of the center of buoyancy was also estimated for the displacement to each waterline. These calculations assumed that the ship did not lift off the groundways as the after part became immersed, and it is also clear that the trim differed widely from the water-borne condition, because the keel was at a declivity of 5-8 in. to the foot, and in a length of 390 ft. this gave a difference of draft at the fore and after perpendiculars of 5-8 × 390-12 ft. = say, 20 ft. 4 in.; while the trim by the stern when the vessel was afloat was only 3 ft., and her fully laden condition is designed for an even keel.

The results of these calculations, and the moments of weight and buoyancy about the after end of the ways and the fore poppet, are plotted in Fig. 2, where the abscissæ represent the travel of the ship down the ways. The weight being constant is shown by a straight line parallel to the base. The curve of buoyancy intersects this at a point *A* after the ship has traveled 337 ft., when she is fully water-borne. The center of gravity of the ship was over the after end of the ways when she had moved 277 ft., when, of course, the moment of weight about this point was zero, while there was then a large positive moment of buoyancy, which was maintained and increased relatively to the moment of weight until the ship was fully afloat. There could therefore be no tipping motion while on the ways. Although when the weight of the ship was taken on the cradle, the pressure per square foot on the groundways was not uniform, it only varied with the relatively small variation in the weight of the ship per foot of length as built at time of launching, when generally there is but little local concentration of weight due to such fittings as armor, machinery, etc. As buoyancy is gained in launching, a point is reached when the fore end of the cradle is alone in connection with the groundways, and it is there the local stress in launching is greatest. This is shown in Fig. 2, where the moment of weight about the fore poppet, being constant, is represented by a straight line parallel to the base, and the curve of moment of buoyancy about the same point intersects it at a point *B*, corresponding to a travel of 302 ft. when the stern of the ship commences to lift. The compressive force on the fore poppets at this moment is shown by the difference or ordinate *C D* between the curves of weight and buoyancy, and was equal to 1,320 tons, or 660 tons on each poppet, which had an area of 25 sq. ft., and therefore bore momentarily a stress of 26.4 tons per sq. ft. The mean pressure per square foot of bearing surface of the cradle between the fore and after poppets when in position on the slip differs considerably with different ships, ranging from about one to three tons, which is very seldom exceeded. In this instance it was 2.5 tons.

While it is not generally necessary with warships to determine whether they will have stability in the launching condition, because they are designed to be stable, however light, yet such a calculation is made, and both the vertical position of the center of gravity and the metacentric height are ascertained. The latter in this case was 12 ft. The trim of the ship when afloat was also estimated, and showed that she would not be fully water-borne when the cradle left the end of the groundways, but would drop about 4 ft., for which there was ample depth of water. The details of the structure of groundways and cradle, and the internal shoring of the ship to enable the strains developed in launching to be effectively distributed and safely borne, are worth description.

GROUNDWAYS.

The groundways were 427 ft. long, and 6 ft. 6 in. wide, and were laid on transverse blocks of oak in wake of each "land tie," or wood foundation, of the slip, spaced about 5 ft. 9 in. apart. Between the oak blocks were two of fir, equally spaced for about two-thirds the length of the slip, until near the position of the fore poppet already referred to, where the stern of the ship commences to lift. Below this the blocks were of oak or teak, laid side by side. The upper surface of the blocks was trimmed throughout to the camber, and covered with 5 in. teak plank, secured with 3-4 in. bolts, 9 in. long, rag-pointed, and punched down below the surface at least 3-4 in. to obviate all danger of their protruding under the compression of the ways and obstructing the launch. The butts of these planks were well distributed, and were beveled, as shown in Fig. 8, to facilitate the travel of the cradle over them. The foremost planks in each strake were made as long as possible, doweled into the blocks, and extended well abaft the fore end of the cradle. Through these planks was bolted the large cleat *A* (Fig. 4), which formed a base for the pressure of the hydraulic pumps, provided for pushing the ship off, if necessary. On the outer end of these groundways a "ribband" *A* (Figs. 7 and 9), 12 in. × 10 in., extending the whole length of the ways, was fitted. It was of fir, except the upper 30 ft., which was of best English oak. The general security was 3 1-2 in. wood dowels, about 5 ft. apart, for about 300 ft. down, with intermediate bolts 1 in. in diameter, except at the fore end, where they were 1 1-8 in. The plank of the groundways on which the ribband rested was also doweled to the transverse blocks in wake of the land ties below it, as well as bolted like the other plank. The oak ribband, whose fore end took the thrust of the dogshore, was doweled to the plank, and bolted alternately through it to each transverse block of the groundways, and had a steel shoe at the fore end whose faying surface against the dogshore was planed *B* (Fig. 7). This ribband was laid so that when the cradle was in position there should be a clearance between the two varying from 1-2 in. at the upper to 2 1-4 in. at the lower end of the ways. This provided against the cradle jamming between the ribbands as the ship went off, and the increased clearance at the lower end gave play for some small amount of swerving on the ways if the tide caught the ship before she was fully afloat. To resist the tendency of any such movement to carry away the ribband, each piece was shored not only at the butt, but also in mid-length, the shores being about 10 ft. apart in wake of the cradle and 20 ft. below. To prevent the shores, which are fitted below high water, from lifting under the action of the backwash as the ship went off, they were bolted to the groundways and lashed to the land ties of the slip at their outer ends. The three ribband shores at the fore end of the cradle were only 5 ft. apart. The outer ends

FIG. 2 BATTLESHIP LAUNCHING CURVES

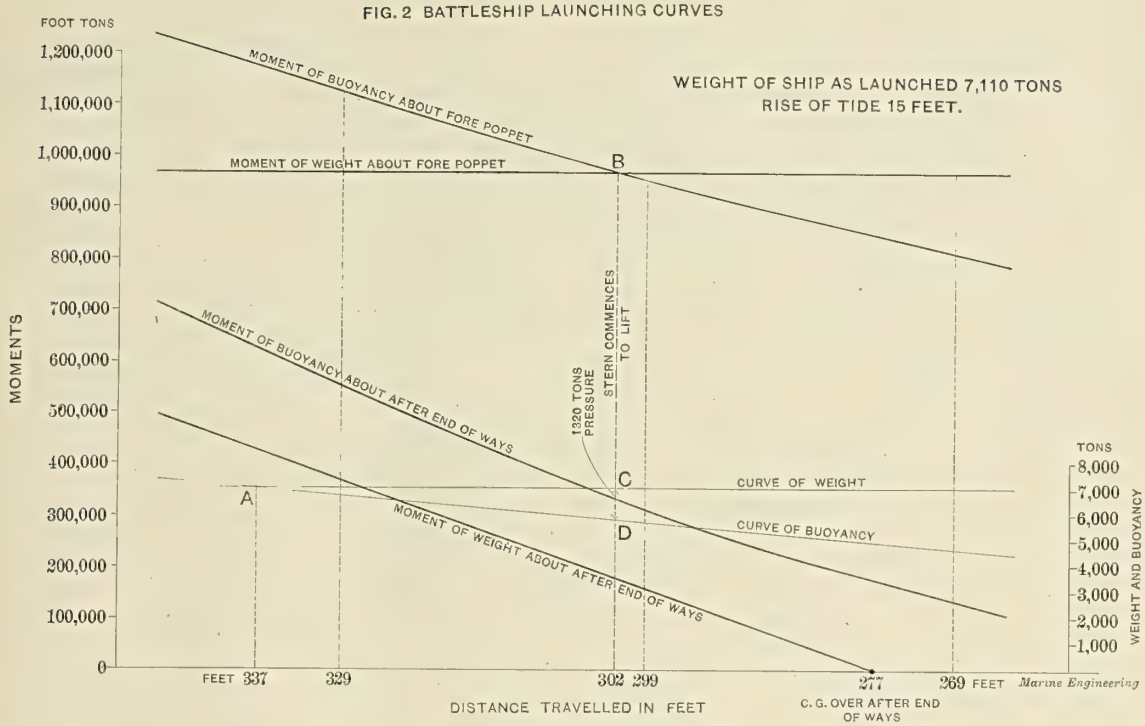


FIG. 2.—BATTLESHIP LAUNCHING.

of all these shores butted against the solid masonry at the sides of the slip.

CRADLE.

The general construction and component parts of the cradle will be understood from Figs. 3 to 18 inclusive. The fore end of it was about 65 ft. abaft the stem, and the after end at the extremity of inner shaft tube, both being in wake of one of the main transverse bulkheads. Resting on the groundways are the bilgeways, solid timber structures of Dantzic fir, 310 ft. long, 5 ft. wide, and 2 ft. thick, the lower surface being faced with 4 in. teak, called the "sliding plank." The fir section of 20 sq. ft. was made up of four balk with plain butts, the several lengths well overlapping and being bolted and doweled together. The teak sliding plank was fastened with 3-4 in. rag-pointed bolts, 8 in. long, the heads being punched below the surface at least 3-4 in., as described for the fastenings of the groundways, and for a similar reason. The ends of the bilgeways were built up by cleats, *B C* (Figs. 4 and 5), and thus formed stops

FIG. 3 GENERAL ARRANGEMENTS

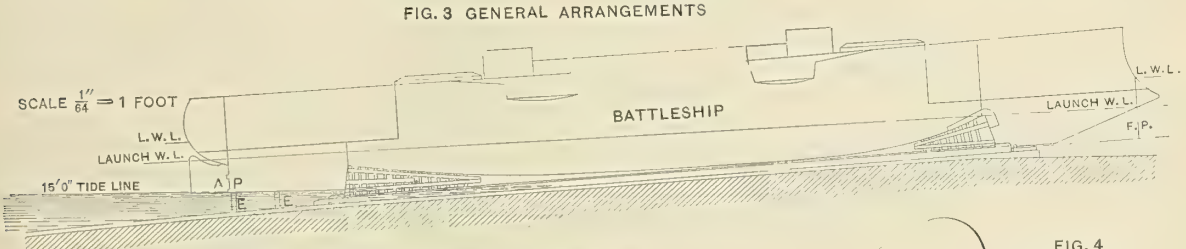

SCALE 1/64" = 1 FOOT
BATTLESHIP
L.W.L.
LAUNCH W.L.
F.P.
L.W.L.
LAUNCH W.L.
15'0" TIDE LINE
A P
E E
LAUNCHING WEIGHT 7,110 TONS
LAUNCHING DRAUGHT { 14'5" FORWARD / 17'5" AFT.
CAMBER IN GROUNDWAYS 9" IN 300 FEET.
TANGENT TO GROUNDWAYS AT AFTER PART 5/64" DECLIVITY TO 1 FOOT
AREA OF SLIDING WAY SURFACE 3,100 SQ. FT.
PRESSURE PER SQ. FOOT ON DITTO 2.5 TONS
SPREAD OF BILGEWAYS OUT TO OUT 35'6"

FIG. 4
FORE PART
SEE FIG.7

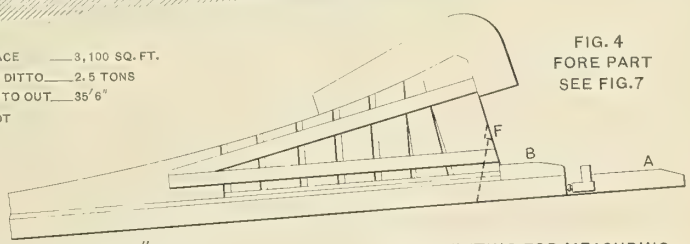


FIG. 5
AFT PART SEE FIG.12

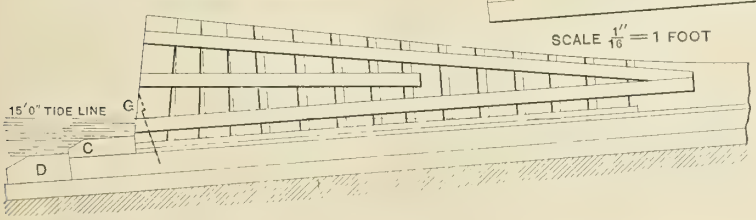
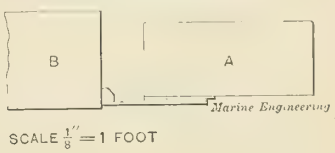


FIG. 6 FITTING FOR MEASURING "DRAW" OF SHIP



FIGS. 3, 4, 5 AND 6.—BATTLESHIP LAUNCHING.

for the heels of the end poppets. As the fore end of these bilgeways had to bear considerable stress, the cleat was of English oak the full width of the ways and strongly bolted to them, and on its outer side was fitted the dog-cleat of English oak, 1 ft. square in section, fastened not only with dowels, but with 1 1-4 in. galvanized bolts passing right through the cleat, the heads bearing on a steel face-plate to the dog-cleat 5-8 in. thick, and the points have up on a similar plate, as shown on plan and section through *CD* (Figs. 10 and 11). The after end of this dog-cleat was fitted with a steel shoe *E*, similar to that at the fore end of the rib-band. The space between these two points was filled by the dogshore of African oak, 10 ft. long and 1 ft. square in section, having a steel shoe at each end *FG*, similar to those it bore against. It was this shore on each side which, with the few blocks remaining under the keel just before launching, and the friction of the grease on the ways, prevented the ship from being launched. Fig. 7 shows that the shore was cut at the fore end to such an angle that it cleared itself as it fell.

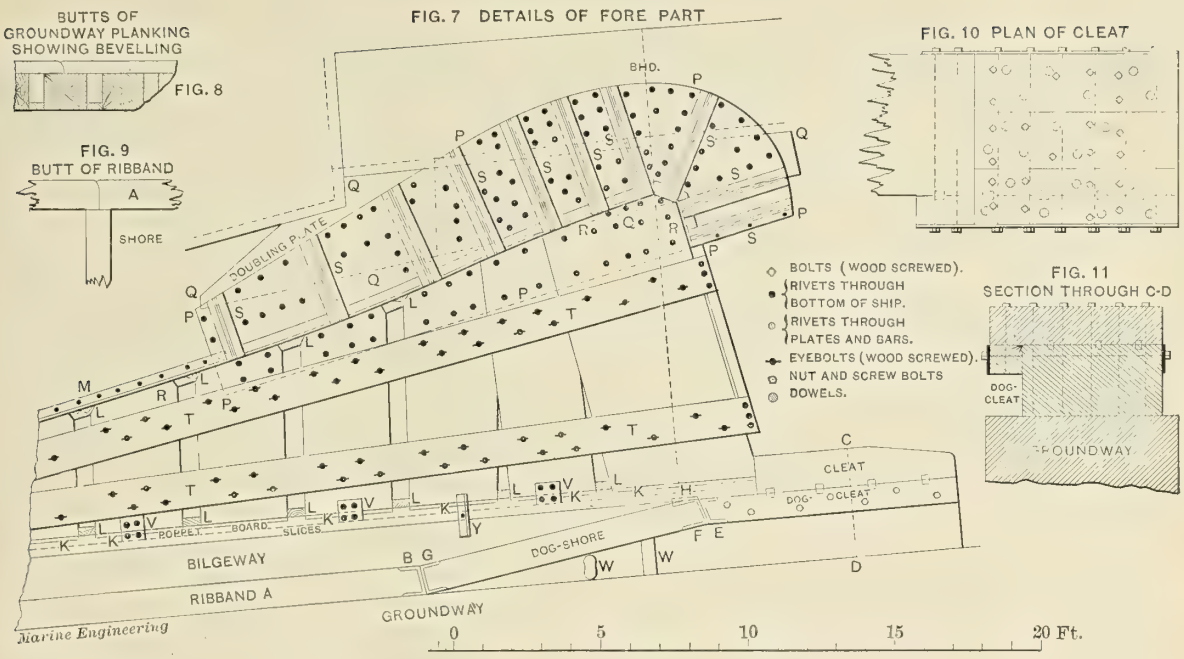
A trial of this is always made when the shore is first fitted, and before any strain comes upon it, by letting a dummy weight fall upon it. The wedge-shaped steel face *H* on top of the dogshore, immediately under the weight, had its upper surface square to the direction of the blow, the full effect of which was thus transmitted to the shore. While the exact resistance to be overcome in knocking away the dogshore cannot be determined, a rough estimate on the safe side may be made by resolving the weight of the ship parallel to the thrust of the shore, and assuming that the blocks remaining under the ship and the grease upon the ways bear no part in resisting this. We thus get a crushing force on each shore of about 240 tons, and taking the coefficient of steel on steel as 0.3, and allowing that the shore clears itself after about 1-2 in. of travel, which is really the case, we get—

Work to be done $= 240 \times 0.3 \times \frac{1}{24} = 3$ ft. tons.

The work due to the fall of half a ton through 17 ft., which was provided for, is 8 1-2 foot-tons, which, with the other assumptions in favor of the pressure to be overcome, gave sufficient margin for safety. The remainder of the cradle above the bilgeways consisted of three parts, the stopping up—amidships—and the fore and after poppets. The stopping up, which, like the poppets, was of the full width of the bilgeways, namely, 5 ft., consisted of solid Dantzic fir timber carefully fitted to the bottom of the ship, and 192 ft. long. The poppets varied from 15 to 25 sq. ft. in sectional area, and were nearly vertical, except the first and last two or three, which stood rather more square to the surface of the bottom in a fore-and-aft direction. The heels of these poppets were steadied by tenons 9 in. wide and 1 1-2 in. deep, which fitted a fore-and-aft groove *KKK* (Figs. 7, 12 and 18), in the 6 in. poppet board of English elm below them; the spread of these poppets at the heel just above this board, and also at the head, was preserved by chocks, *LL*, but the end poppets, especially those forward, were close fitting from the head well down their length. The various pieces composing them were not only bolted together like the others, but were also doweled. Each set of poppets was connected together outside the cradle by steel "dagger" plates, *TT* (Figs. 7, 12 and 16), three aft and two forward, 14 in. wide and 3-4 in. thick, secured to the poppets by Blake's screws, and extending far enough from each end to overlap and be fastened to the stopping up. Between the upper surface of the bilgeways and the underside of the stopping up and poppet board, was a space of 4 1-4 in., in which the "slices" or beech wedges, 6 ft. 6 in. long, were inserted when it was desired to "set up" the ship, *i.e.*, to take the weight on the cradle and off the blocks sufficiently to enable the latter to be rammed out. To prevent the cradle falling outward at the head, a steel angle *M* (Figs. 7 and 12) was riveted to the bottom of the ship, extending from near the fore end to the extreme after end, where it was turned down over the aftermost poppet. The position of the after poppets, and the shape of the bottom there, gave their heads a much better bearing against the ship than was the case forward, and as the after end of the ship was soonest water-borne, and the poppets there were not subject to the great stress of those forward, it was not necessary to do more than support the angle referred to by the bracket plates shown at *NN* (Fig. 12), which in each case were continued as far as the projecting edge *OOO* of the bottom plate above. At the fore end special strengthening was necessary for reasons already stated, and is shown by Fig. 7, where the plate *PPP* was of 1-2 in. steel, with a similar plate, *QQQ*, riveted at the back of it, and fitting closely between the projecting edges of the bottom plates above and below it, thus greatly stiffening the structure to resist shearing of the fastenings. Over the heads of the poppets a 5-8 in. steel plate, *RRR*, riveted to a 7 in. by 3 1-2 in. by 5-8 in. angle bar, was fitted and turned down over the fore end of the foremost poppet, the connection being stiffened by ten brackets, *SSS*, formed of 1-2 in. plates and double steel angle bars. All the parts of this plate and angle structure were most carefully fitted to each other and the bottom, the only connection to the latter by 1 in. steel rivets through the plating between the brackets. The single shearing stress of each rivet is assumed at twenty tons.

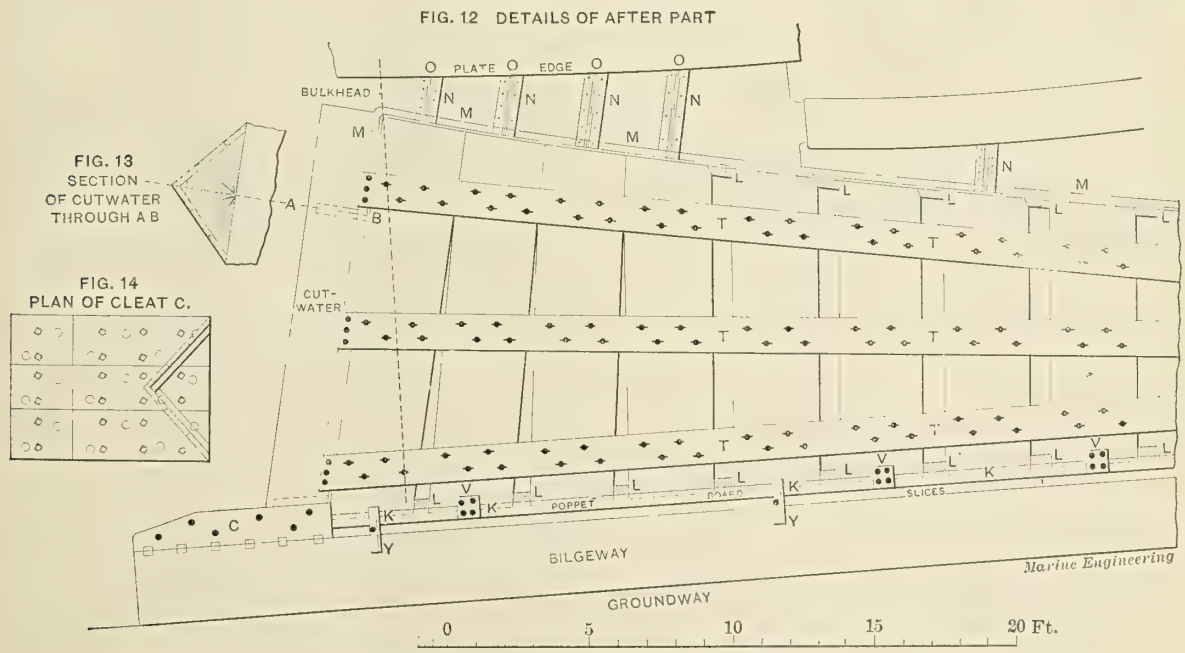
This structure might yield in two ways: (*a*) by the shearing of all the rivets in the brackets and angle bars over the heads of the poppets, or (*b*) by shearing all those through the bottom, and also those through the brackets and doubling plate. The pressure on the fore poppet when the stern began to lift has been given as 660 tons, and this may be resolved into a tangential stress of 585 tons, and one of 320 tons normal to the bottom. Assuming this tangential stress distributed by means of the structure over the area surrounding the heads of the foremost three poppets, we should have to shear about 120 rivets in case (*a*), giving a total shearing stress of $120 \times 20 = 2{,}400$ tons, and a factor of safety $= \frac{2400}{585} = 4.1$, which is ample. Fracture in case (*b*) would need a shearing stress of $167 \times 20 = 3{,}340$ tons, or a factor of safety $= \frac{3340}{585} = 5.7$.

In order that the two parts of the cradle should preserve their relative positions during launching, spread shores, about 12 in. square and ten in number, were fitted between them under the keel, and resting in English elm cleats secured to the bilgeways (Figs. 16 and



FIGS. 7, 8, 9, 10 AND 11.—BATTLESHIP LAUNCHING.

17). One of these shores was at each end of the ways, one opposite the fore end of the dogshores, and the remainder divided the intervening length about equally. These acted as struts. Between them at the butts of the stopping up, spread chains were fitted as ties, setting up to 1 3-4 in. steel eye-bolts, through the stopping up, the bolts being hove up on plates covering the butts on the outside of the cradle (Fig. 15). These spread chains were not fitted to the wake of the poppets. No part of the cradle was attached to the bottom of the ship, and as it was fitted below the bilge keel, and had a certain amount of buoyancy, it might leave the ship as soon as she was afloat, and be held under the bilge-keel, unless this were provided against. To keep it clear, T bars or double angles were fitted, as shown by *B* (Fig. 15), at intervals of about 15 ft., tapped to the bottom of the ship and bilge-keel, and having a wood strut *C* above each in the angle formed by the bilge keel and bottom of the ship. The close fitting of the cradle, and the pressure developed in launching, generally make the cradle adhere so firmly that it must be pulled out by tugs, as it is necessary to remove it



FIGS. 12, 13 AND 14.—BATTLESHIP LAUNCHING.

for the safety of the ship in docking. For this purpose steel-wire hawsers were separately attached to the fore and after ends of the cradle, and to each piece of the stopping up, the ends of the hawsers being carried inboard on the upper deck till wanted.

INTERNAL SHORING.

While the fullest use was made of the structure of the ship to prevent any alteration of form under the strains borne in launching, by having all possible pillaring complete, and all bulkheads and flats riveted off, it was necessary to provide some internal wood shoring, as shown in Figs. 15 to 18. The spread of the cradle from out to out was 35 ft. 6 in. (Fig. 16), which caused it to bear directly under one of the longitudinals for a great part of its length (Fig. 15). Short shores were also fitted, as shown between the inner and outer bottoms, above the edges of the cradle, and a covering balk was laid on top of the inner bottom, from which stout shores reached to the protective deck. The great strength of the framing between the inner and outer bottoms for the engine bearers, and that of the bearers themselves, which were complete, made special shoring at that part unnecessary, but for the remaining length of the cradle, and particularly abreast of the foremost poppets, it was provided, and at the latter place the structure was stiffened from one side of the ship to the other (Fig. 18). The total weight of these shores was about 90 tons.

LUBRICATION OF SLIDING SURFACES.

The whole of the work already described was completed a fortnight ago before the launch, when preparations were made for applying the lubricants to the sliding surfaces. For this purpose the whole of the cradle above the bilgeways was temporarily suspended to the bottom, on the outside of the cradle, by strips of 1-2 in. plate, *A* (Figs. 15 and 16), tapped through the bottom of the ship and screwed to the cradle. On the inside, wood struts, *D* (Figs. 15 and 18), 6 in. by 6 in., resting on the bottom of the slip, and screwed below to the groundways and above to the cradle, kept the latter in position against the bottom of the ship. The poppet board was secured to the poppets, both inside and outside the cradle, by plates, *VVV* (Figs. 7 and 12), screwed to both, and left in position until the ship was afloat, which prevented the board from leaving the poppets and sinking, as, being of English elm, it might do. The ribband on the outer edge of the groundways was then removed, and 5 in. plank *E* (Fig. 18), fixed at intervals from 20 ft. to 30 ft, with its inner end at top level with the top of the groundways, and sloping up and outward The bilgeways were next hauled by steam winches on to these supports, and the remainder of the cradle was temporarily shored up from the groundways *F* (Fig. 18).

After a careful inspection of these surfaces, the lubricants were applied first to a short length of the ways, which was coated to the required thickness, and then loaded over a portion of its surface to the mean pressure of 2.5 tons per sq. ft. by ballast, this load being launched, and testing the adhesiveness of the lubricant to the groundways and its adaptability generally for its work. The exact position of the bilgeways having been razed in on the groundways for fitting purposes, wood battens 1-2 in. thick were nailed to these lines, and the space between them coated with Russian tallow applied hot until a solid coating 3-8 in. thick was obtained. It is sometimes an advantage to mix beeswax with the tallow in order to assist the cohesiveness of the lubricant and prevent it from cracking and caking. On this a coating of "slum" was placed, made up of Russian tallow and train oil boiled together and well mixed in the proportion of four gallons of oil to 112 lb. of tallow, being one part oil to two of tallow. This was not applied hot. The proportion of oil varies with the temperature of the atmosphere, being less in hot than in cold weather. The surface of the slum was irregularly grooved, after which train oil was poured upon it, and finally soft soap scattered in patches throughout the length of the cradle. The under surface of the bilgeways was coated with Russian tallow similarly applied, but only to a thickness of about 1-2 in., on which the slum was placed. The side of the ribband next to the bilgeways was also thickly coated with slum, and the narrow space between them sprinkled with oil. Across the surface of the groundways, forty grease irons, *GG* (Fig. 18), to keep the bilgeways clear of the groundways while being hauled back, were then placed in pairs and steadied on the inside of the cradle by workmen, until the bilgeways were hauled again into their proper position, and fayed against the struts previously described as supporting the cradle against the bottom of the ship. The grease irons were withdrawn, the battens removed, and the long beech slices, of which about 1,300 were used, were inserted between the bilgeways and upper part of the cradle, except those below high water, which were not put in until it was necessary to drive them, and so were kept dry. The temporary struts and angle supports to the cradle were next removed, the ribband on the outer edge of the groundways were replaced, fastened, and shored, the holes through the bottom of the ship were plugged, and the cleats on the bilgeways replaced and bolted. A large cleat, *D* (Fig. 5), was also bolted to the groundways at the lower end of the cradle to prevent any premature sliding movement. Ten steel keys, *E* (Fig. 15), on each side, varying regularly from 1-2 in. to 1 3-4 in. in thickness, from fore to after end of bilgeways, were then inserted at equal distances between them and the ribband, and maintained them in position. Battens *F* were nailed over this groove to prevent any substance getting in which might obstruct the launch. The remaining slices were inserted, the dogshores were placed, and two "triggers," *WW* (Fig. 7), put beneath each, that with a plain beveled end preventing the shore from falling, and the other with rounded end serving the same purpose when just before launching the former was removed. Between the slices at intervals were twelve steel angles *YY* (Figs. 7 and 12), on each side of the cradle, connected by bolts hove up with nuts, and these helped to keep the sides of the cradle in position and flush with those of the bilgeways.

SETTING UP THE SHIP.

Preparations were then made for "setting up" the ship. This operation is generally begun the day before the launch, the after portion only being dealt with at that time, say, for about one-fourth the length of the cradle. For this purpose the slices were manned both inside and outside the cradle by shipwrights with heavy

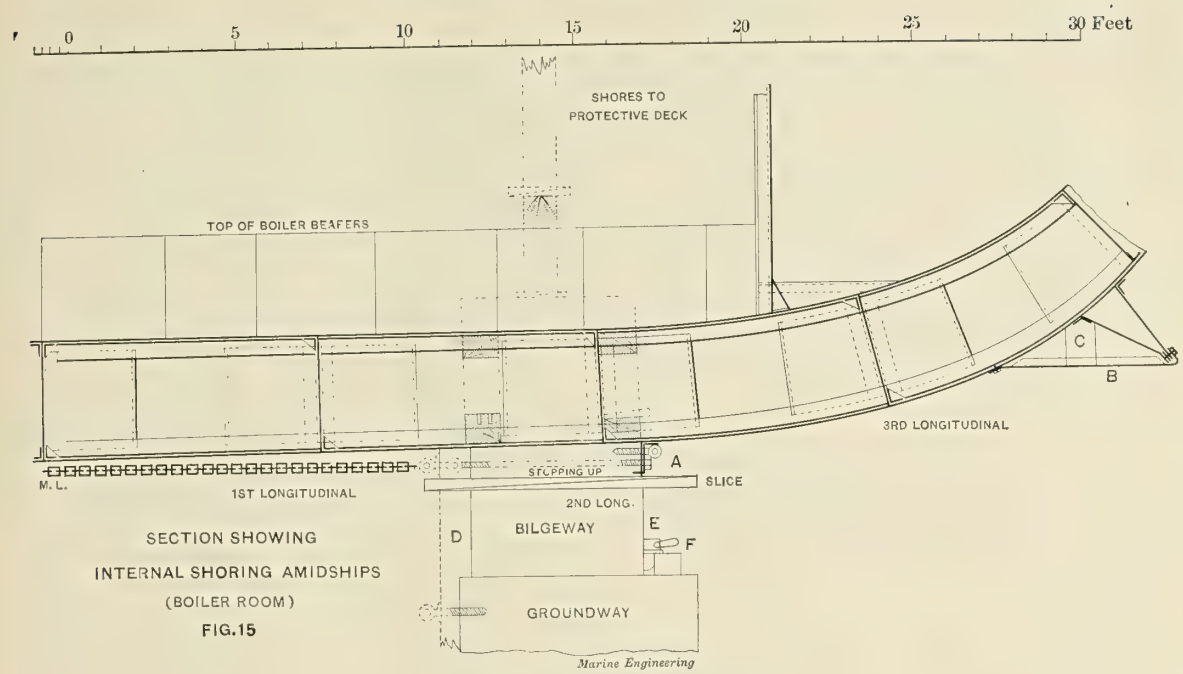


FIG. 15.—BATTLESHIP LAUNCHING.

mauls. The shores at this part were also manned and kept effective as the setting up proceeded by tightening the wedges under them. At a given signal the whole of the men struck together. The strain on the building blocks was tested at intervals by striking the wood wedge blocks, *HH* (Fig. 18), of each tier until it was clear that they had been relieved sufficiently to enable them to be readily removed. This removal followed immediately upon the conclusion of the setting up, and the building shores under the bottom inside the cradle were also taken away, the remaining shores outside the cradle being roped at the head and the ropes carried inboard in readiness for lowering them on the launching day after completing the setting up. As the blocks were removed, "skeg" shores, *EE* (Fig. 3), rounded at each end, were placed under the keel at intervals to assist in supporting the overhanging part of the ship beyond the cradle and the blocks left standing. These shores are generally left in position until the ship is launched, the form of their ends making it easy for her to trip them as she moves. The drying and lubrication of the ways below the cradle was carried out on the morning of the day of launch as the tide ebbed, and finished as it rose. The completion of the setting up commenced at about the same time, and somewhat abaft where it was left the day before, and was continued until near the fore end of the cradle. It is not usual to set up the extreme forward end, but only to tighten up the slices there as necessary to give them a proper bearing. Three or even four slices were allotted to each man in setting up. When this work was finished the heads of the slices were roped together, as they have some buoyancy and might otherwise float away singly when the ship was launched. The remaining shores between the cradle were removed, and the dogshores were tightly set by driving a thin steel wedge between them and the fore end of the ribband on the groundways. Additional security was given to the foremost and aftermost poppets

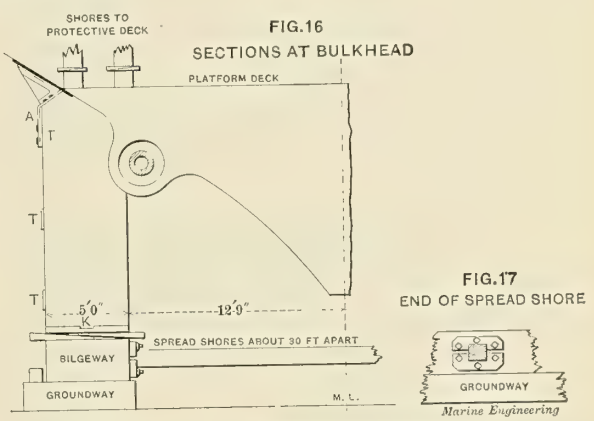


FIG. 16 AND 17.—BATTLESHIP LAUNCHING.

by driving two long bolts through each into the bilgeways *F* (Fig. 4) and *G* (Fig. 5), and to somewhat lessen

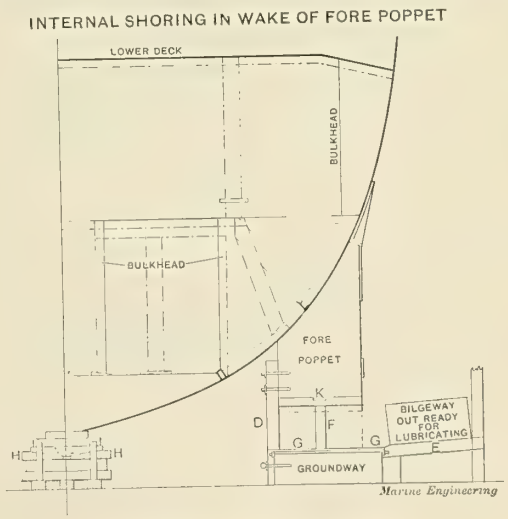


FIG. 18.—BATTLESHIP LAUNCHING.

the resistance a cut-water was fitted against the aftermost poppet. The remaining building shores were then knocked away, commencing from forward and working regularly aft, as the foremost shores tend to push the ship down the slip, while the after ones act as struts against this.

The completion of the setting up was effected in time to enable all these shores to be got away before the rising tide reached the aftermost. It frequently happens that as the remaining keel blocks are removed, and the ship settles down on the cradle, she moves slightly or "draws," and before knocking away these blocks means are adopted for measuring this movement by fixing two battens parallel to but not in contact with each other, one to the fore end of the sliding ways, and the other to the side of the fixed cleat at the fore end of the groundways, and with their upper edges in the same plane. Across the edge a line is transversely drawn, and whatever slight sliding motion takes place is shown by the distance between this line on the fixed and the moving batten (Fig. 6). A corresponding "tell-tale" was also fitted to the stem of the ship upon the launching platform. The difficulty of getting the keel blocks away varies greatly with different tiers, depending partly upon unequal crushing of the blocks during building, and the extent to which the ship is set up and afterward settles upon the cradle and blocks. Generally the excessive pressure is only upon a few tiers of blocks, and, as the hour of launching draws near, may be only upon one tier. As a rule, upon the day of launching, the blocks are only removed sufficiently in advance of the tide to permit the work to be done. This remark applies also to the removal of the bilge cleat at the after end of the bilgeways, and to that of the steel keys and battens on top of the ribband. Should the ship be lively and draw to any extent, some tiers of blocks would be replaced and the ship would be allowed to trip them in launching. If, however, the tell-tales show no sign of movement in the ship, the removal of the blocks would proceed right up to the time of launching, and it might even happen that no blocks would remain under the keel when the dogshore fell, but this extreme is not usual. Experience must guide in this matter in connection with the circumstances of each case, and ships of the size now described have been launched with as many as nine-and-twenty tiers of blocks standing, and with as few as one. The removal of the blocks is facilitated by the method of building them; the wedge blocks *H* (Fig. 18), generally soon yield to the blows of a ram, but in addition to this, the thin top or "cap" block is usually of some straight-grained but fairly hard wood, such as teak, which has to be split out by steel wedges when the ram fails. The use of gunpowder for this purpose has been known in a private shipbuilding yard.

HOGGING AND SAGGING.

After the ship was set up, means were taken to ascertain how much the elasticity of the structure allowed her to alter form, both longitudinally and athwart-ships, from the land-borne to the water-borne condition. As great a length as possible on the upper deck was chosen, and three vertically adjustable sight battens were carefully fixed, one toward each end and one about amidships, the edges of the battens were carefully sighted, so as to be in one plane, and the positions were marked upan the fixed framework carrying the sights. Similar adjustments were made after launching, and the differences afforded a measure of the droop of the ends of the ship relatively to the middle, or *vice versa*, known as hogging and sagging respectively. Athwart-ship observations of this kind are only made in the ships of greatest beam, and seldom show an appreciable movement. In the case of the *Ocean*, the "breakage" by hogging in a length of 312 ft. was only 5-16 in., and in a breadth of 61 ft., nil.

FREEING DOGSHORES.

Each weight of 1,120 lb. for freeing the dogshore was placed in position on the day of the launch at the top of a shoot which allowed a drop of 17 ft. The weights had been suspended for ten days previously by the white manila rope to be severed at the moment of launch, so that the rope had been fully stretched before the weight was finally put into position. This rope was led over a sheave at the top of the shoot to the front of the ship's ram, and lashed across a wood chock there. The framework of the shoot, consisting of steel angles at the corners, and so having open sides, admitted readily of the insertion of a shore to take the strain of the weight off the rope until the last moment. A tide gauge was fixed at the after end of the groundways, and the height of water over the groundways was recorded in sight of the launching platform every quarter of an hour during the last hour and a half before launching. The number of the blocks remaining under the keel was similarly recorded as each tier was removed. It is not often that the blow of the weight fails to free the dogshore and release the ship, but in case of failure men are ready to cut away this shore with axes, until its weakened section causes it to yield. This operation is dangerous not only to the men, but may be so to the safety of the ship if one shore yields before the other. To assist the ship to start on the fall of the dogshore, a hydraulic pump of 150 tons pressure was placed on each side at the fore end of the bilgeways, and one of 80 tons in reserve. There was also one of 500 tons directly beneath the stem, to ease her off the groundways. Special care was taken to test the efficiency of these pumps, both before and on the day of the launch, and also to see that they were not exerting any pressure until the dogshores had actually fallen.

WATER-TIGHT COMPARTMENTS.

As the work of building progressed, all compartments below the calculated launching draft of the ship, and as many more as possible, had been completed and tested for water-tightness, and the permanent doors or other means of access were also in place and closed before launching. All Kingston valves, sea-suctions to pumps, inlets and discharges through the bottom, were tested and certified to be tightly closed. Two 9 in. Downton's pumps were completely fitted on board to give some power of ridding the ship of water if necessary, and the sluice valves on bulkheads, and watercourses to the pump suctions were all seen to be clear. Men were launched in the ship to make an inspection of all compartments below water as soon as she was afloat, and report the result.

THE LAUNCH.

All being thus in readiness, the tide gauge showing sufficient water, and the harbor reported clear, the men removing the blocks were withdrawn, the shores supporting the weights were taken out, the triggers beneath the dogshores were removed, and the rope holding the weights was severed, knocking away the dogshore, which, together with the weight, was pulled clear of the ways, and the ship was free. No observation of the launching velocity was made, but as a series of such records for various ships launched on the same groundways with different building declivities and launching weights would furnish useful information, it may be possible at some future time to supplement the present paper by a discussion of such particulars. The speed in launching is checked in many private yards by heavy anchors bedded in the ground, and with lengths of cable ranged alongside the groundways, the ultimate tautening of the cable checking the ship. This is suitable and necessary where the ship is launched into a channel of comparatively small extent relatively to her length, and the distance she would travel if free; but the ordinary means of dropping anchor are adopted in the Government yards where the channel is ample enough for the ship to go well out and swing up into the tide when the cable is slipped. If possible, the wood cradle is pulled out before berthing the ship, but generally this is done more at leisure on days subsequent to the launch and before docking.

Eastern Shipbuilding Co.—Another addition to the shipbuilding facilities of the country is shortly to be made by the establishment of a large ship and engine plant on the Thames river at Groton, opposite New London, on the Connecticut shore of Long Island Sound. The promoters of this new enterprise have taken out incorporation papers under the name of the Eastern Shipbuilding Co. Charles R. Hanscom, late general superintendent of the Bath Iron Works, is the president and general manager of the new company and John Sherman Hoyt, of New York, is the treasurer. William A. Fairburn will act as assistant to the general manager, with duties as naval architect and engineer. Mr. Fairburn has been associated with Mr. Hanscom for a number of years, and until recently at the Bath Iron Works. Among those who are understood to be financially interested in the new corporation are C. W. Morse, of New York, and James J. Hill, of St. Paul, Minnesota. The site already selected for the location of the yard consists of a tract of about 30 acres, formerly held by the N. Y., N. H. & H. R. R. Co., and it has a splendid water frontage within a mile of the mouth of the Thames river. Contracts have already been signed for the construction of three large buildings: The plate shop will be 250 ft. by 80 ft.; the bending floor and furnaces 170 ft. by 60 ft.; and the mold loft and joiner shop 250 ft. by 70 ft. A contract for the construction of two freight and passenger steamships of the largest size has been made between the company and James J. Hill as president of the Great Northern Railroad. These vessels, in respect to tonnage, displacement and deadweight capacity, will be the largest in the world. The dimensions will be about: Length, 650 ft.; beam, 73 ft.; depth, 56 ft.

A SIMPLE EXPLANATION OF THE CONSTRUCTION AND USES OF THE PLANIMETER.—I.

BY CECIL H. PEABODY.

The principles of the action of the instrument called the planimeter, so commonly used to measure the areas of irregular figures, like steam engine diagrams, are commonly set forth in so mathematical a form as to be unattractive to many readers; consequently, it is thought that a brief description of various forms of this instrument, together with a simple and yet complete discussion of its principle, may be of some interest.

Fig. 1 represents a simple form of the Amsler planimeter, much used for measuring indicator diagrams.

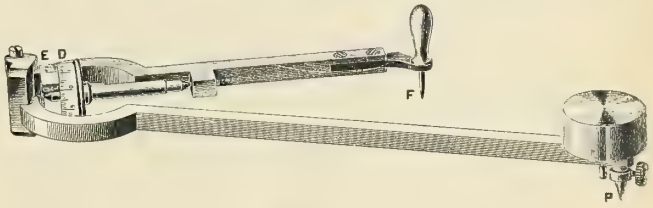


FIG. 1.

It consists of three essential parts, namely: (1) a guiding-arm pivoted at P to the paper, (2) a tracting-arm, which is hinged to the guiding-arm and which carries the tracing point F; (3) a measuring-wheel D which carries a graduated cylindrical scale. There is also an index and vernier for reading the scale on the wheel. When in use the planimeter rests on the paper at three points, the pivot P which is a needle-point

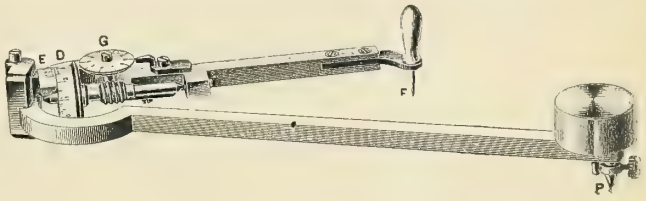


FIG. 2.

thrust into the paper, the edge of the wheel D and the tracing-point F. A weight over the pivot P holds the needle-point down and gives the instrument stability. The instrument is made of German silver and the scale is graduated on celluloid, which makes it easily legible.

Fig. 2 shows the same instrument with the addition of a wheel G to count the number of turns of the measuring wheel.

A somewhat more complicated form with an adjustable tracing-arm is shown by Fig. 3; the measuring-wheel D and the recording-wheel G are on a prolongation of the tracing-arm beyond the hinge.

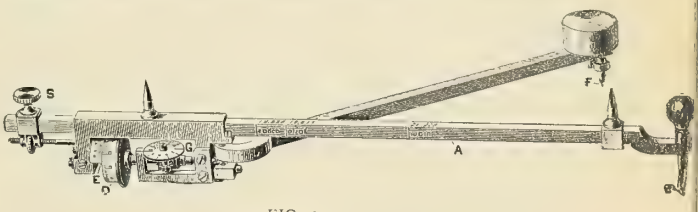


FIG. 3.

The instruments shown by Figs. 1 and 2 measure

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areas in square inches, one entire revolution of the measuring-wheel recording ten square inches; the area may be read to hundredths of a square inch by aid of the vernier. The instrument shown by Fig. 3 may be set to measure areas in square inches, and also in square feet and square centimeters. The points on the back of the tracing-arm are used to set the instrument for convenient determination of mean effective pressure by a method to be described later.

To measure the area of a figure, like an indicator diagram, the instrument is placed as in Fig. 4 so that the arms shall not take inconvenient positions when the outline of the diagram is traced. Make a needle-prick on the perimeter as at the point *F;* place the tracing-point at this needle-prick and set the measuring-wheel to read zero; trace the outline of the diagram in right-handed direction as shown by the arrow; the reading of the wheel will give the area in square inches. The figure represents the planimeter shown by Fig. 3, but the simpler forms are used in exactly the same way. The adjustable tracing-arm of Fig. 3 is supposed to be set to measure areas in square inches.

It is important that the surface on which the measuring-wheel bears shall be flat and smooth, and free

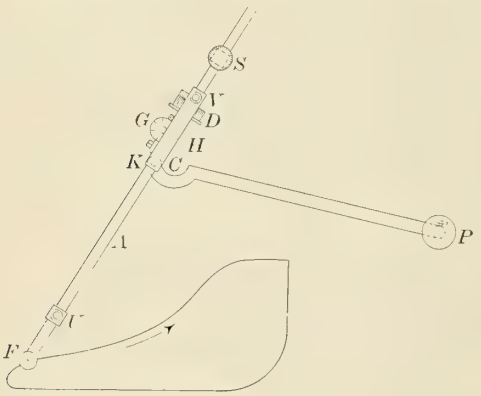


FIG. 4.

from both glaze and roughness. Cardboard or smooth, unglazed paper will answer. If the diagram, for example an indicator diagram, is on a small piece of paper, it is to be pinned securely and the measuring-wheel must not run onto this paper, as its reading will be affected by running over its edge.

For simplicity of statement, the direction was given above to set the measuring-wheel at zero at the beginning of the process of tracing the diagram. In practice it is convenient and customary to omit setting the wheel at zero, taking instead the reading the wheel may happen to have for the initial reading; the reading after the figure has been traced is the final reading; the difference between the initial and final readings gives the area of the diagram.

It is very important that the tracing-point shall be returned exactly to the starting point; a slight deviation may make a considerable error. It is also important that the perimeter of the figure should be followed exactly; some practice is required to gain accuracy and facility. It is well to retrace the figure without deranging the instrument; the difference between the third reading and the first reading is double the area of the figure.

To get a conception of the way in which a planimeter measures an area, we may consider the tracing-arm, with the measuring-wheel, to be separated from the guiding-arm and placed at one side, *hp*, of the rectangle, *hpgi*. Fig. 5. Suppose that the arm is moved

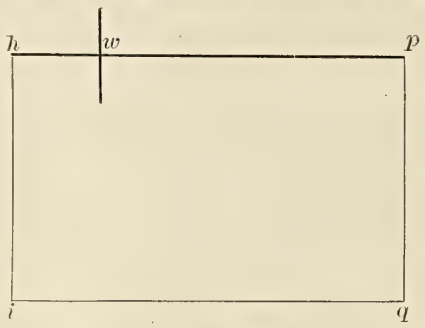


FIG. 5.

parallel to itself across the rectangle *h* remaining on the line *hi;* the wheel will roll without sliding a distance equal to the width of the diagram. Suppose that the arm is 4 in. long from the axis of the hinge to the center of the tracing style or to the tracing-point; suppose, further, that the circumference of the wheel is 2.5 in. (the diameter is then 0.7957 of an inch). If the wheel makes one turn in crossing the figure it will roll 2.5 in., the width of the figure. The area of the rectangle is $4 \times 2.5 = 10$ sq. in. The scale on the wheel can be divided into ten parts, each one of which corresponds to a square inch. The subdivisions of the scale and the vernier allow us to read to hundredths of a square inch.

It may be worth while to interrupt the discussion long enough to see how the vernier is made and read. Let Fig. 6 represent a scale of units numbered *1, 2, 3,* etc., which are subdivided into tenths. The vernier *ab* is as long as nine of the subdivisions and is divided into ten parts, so that the intervals of the vernier are 9-10ths as long as the intervals of the scale; or in other words they are 1-10 of an interval shorter. The index of the vernier reads *1.7* on the scale, and by estimation about half a subdivision more. It will be noted that the 5th division of the vernier coincides with *a* division of the scale; the 4th division of the vernier is 1-10th of an interval from the next mark on the scale, the 3d is 2-10ths, the 2d is 3-10ths, the 1st is 4-10ths, and the index is 5-10ths of an interval from the mark on the scale. Consequently the reading of the vernier is *1.75*. If the measuring-wheel is divided into ten parts, each of which corresponds to a square

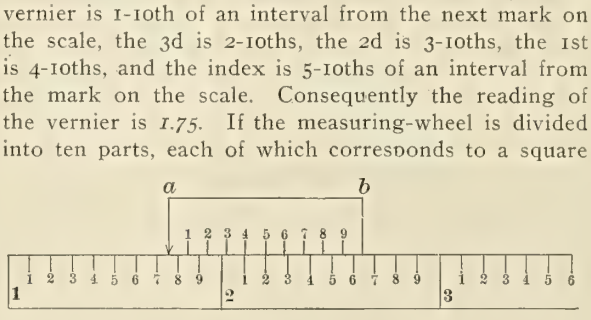


FIG. 6.

inch, then the subdivision and the vernier allow us to read to hundredths of a square inch, as already pointed out.

Returning to the action of the planimeter, consider that the parallelogram Fig. 7 can be measured by moving the arm over it parallel to the side *hp*, keeping the hinge *h* on the line *hi*. During this operation the

measuring-wheel will roll and slide from *w* to *x;* the two motions may be analyzed by drawing *xy* perpendicular to *hp,* whereupon it will appear that the wheel rolls the distance *xy* and slides the distance *wy.* The planimeter records an area equal to *hp* × *xy,* which is

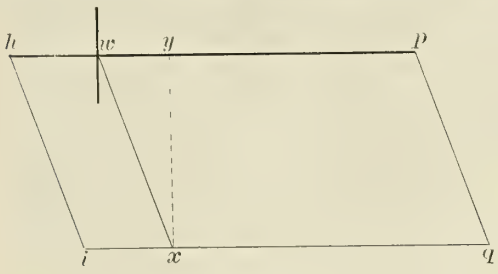


FIG. 7.

equal to the area of the parallelogram under consideration.

The diagram represented by Fig. 8 can in like manner be measured by moving the arm *hp* parallel to itself with *h* on the arc *hi,* during which operation the wheel will roll the perpendicular distance *xy.* It will be noted that the diagram *hpgi* may be transformed into the rectangle *hprk* by transferring the half circular segment *rpq* to *khi.*

We are now ready to see how the planimeter can be made to measure the area of a chosen diagram like *pqrs* of Fig. 9, and afterwards we will see how the method can be extended to any diagram. This figure is described by first moving the tracing-arm parallel to itself from *hp* to *iq,* the hinge *h* being guided on the arc *hi* by the guiding-arm *hg,* during which operation the wheel records the area of the diagram *hpgi;* then by swinging the arm from *iq* to *ir,* during which the wheel rolls over the arc *xy;* then by moving the arm parallel to itself from *ir* to *hs,* during which the wheel records the area of *hsri,* but since the arm is now moved backward the area is subtraced by the wheel which rolls backward; the diagram is completed by swinging the arm from *hs* to *hp,* during which the wheel rolls backward over the arc *zw.* The angles *phs* and *qir* are equal, consequently the arcs *xy* and *zw* are equal, and the effect of rolling *zw* backward counteracts the effect of rolling *xy* forward, so that the final reading of the wheel gives the difference between the areas of *hpqi* and *hsri,* provided, of course, that the wheel reads zero to begin with. But the diagram *pqrs* may be obtained

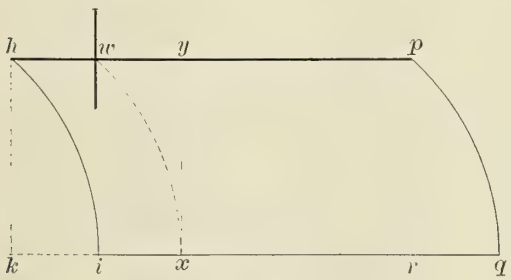


FIG. 8.

by adding *hpqi* and *qiv* and substracting *hsri* and *phs,* of which *qir* and *phs* are equal; so the area of the diagram *pgrs* is equal to the area *hpgi* minus the area *hsri;* that is the reading if the wheel is equal to the area of the diagram traced by the tracing-point.

An irregular figure like an indicator diagram may be replaced by an aggregation of figures like *pqrs,* as in Fig. 10, which shall have approximately the same area as the diagram. Each of these figures can be measured separately by tracing its contour with a planimeter, and their areas can be summed up; or the irregular contour of the aggregation may be traced in one operation omitting lines like *rq,* which are common to two adjacent figures since such lines are traced once in one direction and again in the contrary direction when the figures are traced separately. In Fig. 10 the approximation to the true area of the indicator

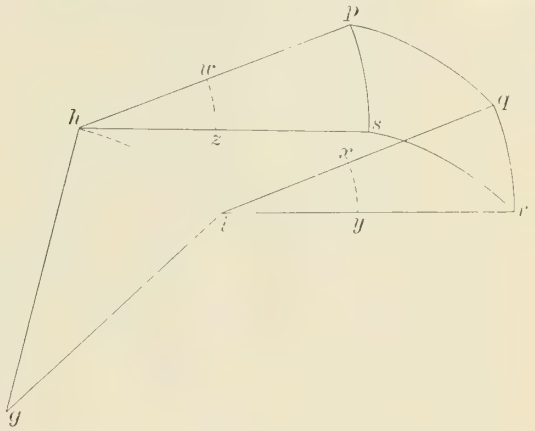


FIG. 9.

diagram may not be satisfactory, because there are only a few large figures like *pqrs,* but by taking enough figures the approximation can be made as close as we please; we may, therefore, conclude that the true area of the diagram will be recorded by a planimeter when

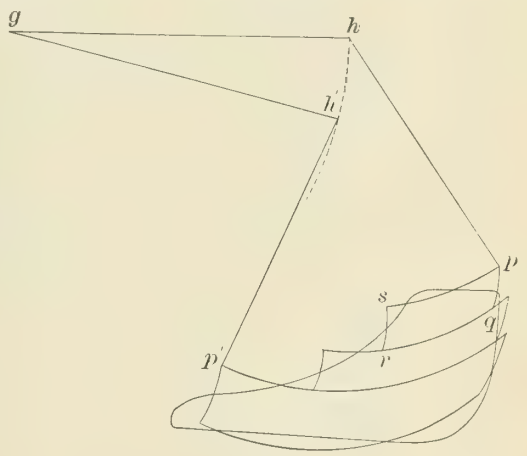


FIG. 10.

the real contour of the diagram is traced, during which operation the tracing arm will have a continuous combined forward (or backward) swinging motion.

The planimeters shown by Figs. 1 and 2 have the tracing-arm 4 in. long and the circumference of the wheel is 2 1-2 in.; one complete turn of the wheel corresponds to 10 sq. in. of area. The main divisions of the wheel (ten for the complete scale) are therefore read as square inches; or the number of revolutions of the wheel (and fractions or decimals of a revolution) may be multiplied by ten to get the area in square inches.

HUGE STEEL FLOATING DOCK AT THE YARD OF BLOHM & VOSS, HAMBURG.

In the accompanying reproduction of a photograph taken recently at the shipyard of Blohm & Voss, Hamburg, Germany, the largest floating dry dock yet completed is shown, with the freight and passenger steamship *Pretoria*, of the Hamburg-American line, 12,500 tons, on the blocks. The capacity of this dock is 17,500 tons, only 500 tons less than the maximum capacity of the new United States floating dock for Algiers, La., now under construction at Sparrow's Point, Md., and which was described in detail in our February issue.

The dock at Hamburg is also built of steel, and is 670 ft. long and 119 ft. 9 in. broad. It consists of seven separate pontoons connected by the high side walls in a single system. The pontoons are arranged so that any of them can be detached for repairs or docked on the dock itself for cleaning. For lifting very heavy, short war vessels of greater weight than the capacity of the pontoons directly underneath, the side walls act as longitudinal girders to transmit part of the lifting capacity of the pontoons not loaded to those which are loaded. It is believed by the designers that in this way the lifting power of the dock is used to better advantage than if each pontoon were made large enough to allow of its receiving the maximum load direct.

There are twenty-one watertight compartments in the dock all fitted with inlet and outlet valves (56 in all), so that any desired change of trim can be readily effected. In each side wall there is an engine room which contains a boiler, built for 180 lb. working pressure, and a set of triple expansion engines. These engines are connected to fourteen centrifugal pumps, of large capacity, for emptying the dock. These rooms also contain generating sets for supplying the electric lights with current, and pressure pumps for operating a hydraulic system for handling the valves. These valves are connected with one central station, in one of the side walls, where the handling gear is located. Water gauges connected with each of the twenty-one watertight compartments are fitted in this room, so that the engineer can see at a glance the condition of each compartment. By a suitable arrangement of levers of the hydraulic gear operating the valves he can regulate the inflow or outflow of water to any or all the compartments, and thus lift or lower the dock as required. This operating room is conveniently fitted up and lighted, so that no matter what the conditions of weather outside—in a snow storm, during rainy weather or on the darkest night—the engineer can attend to his duties in comfort.

During docking, the vessel rests on keel blocks along the middle line, and also on a row of bilge blocks arranged on the ways on either side. By a system of chains and winches situated on the side walls the bilge blocks can be moved transversely or in a fore and aft direction. This dock can be worked with great rapidity —startlingly so to those accustomed to the ordinary dry dock. It is capable of lifting the largest vessel dry in about 45 minutes, and to float the vessel again requires only about 15 minutes.

For warping purposes and taking up the anchor chains of the dock eight capstans are provided on the side walls.

It is the intention of the owners eventually to move the dock to the lower Elbe or Cuxhaven, so that large vessels can be taken on there for cleaning. In case a damaged vessel arrives for repairs, it will be docked there, and then the dock will be towed up the Elbe to the owner's yard where repairs will be effected. Unloaded the draft is about 5 ft., while with the maximum load the draft is slightly in excess of 13 ft., so that the dock with a damaged vessel on the blocks can be towed in shoal water.

This dock was constructed by the owners who also built the two transatlantic liners shown in the photograph. They are both of the intermediate type, in the service of the Hamburg-American line, New York, via Plymouth, to Hamburg. In general dimensions these vessels are practically duplicates. They are: Length, 560 ft.; beam, 62 ft.; depth, 41 ft. They are fitted with twin screws driven by quadruple expansion engines, with cylinders 23 in., 33 in., 48 in. and 69 in. dia. by 54 in. stroke. The gross tonnage is about 12,500 tons. The *Pretoria*, shown on the dock, was turned out in 1897 and the *Graf Waldersee*, lying alongside the wharf, two years later.

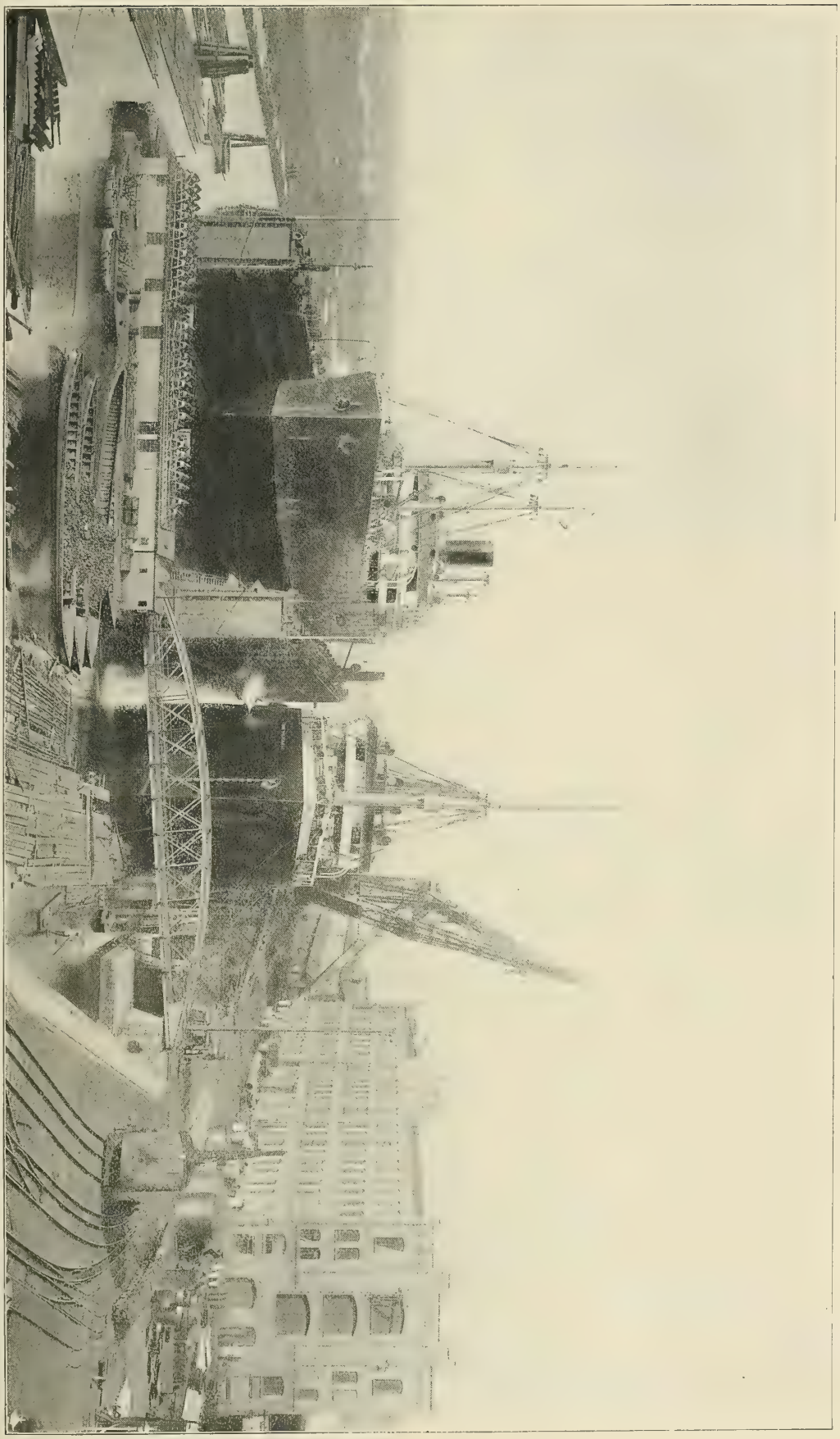
Gasoline Yacht Lady Francis.

In power-driven pleasure craft there is a noticeable increase in the number of vessels fitted with internal combustion engines, which are of larger dimensions that the usual open launch. Nowadays the use of this form of motor is not infrequent in twin screw vessels which in size and general appearance rank with small steam yachts. A vessel of this type recently completed for a Boston owner is the *Lady Francis*, illustrated in the accompanying drawings and photographs.

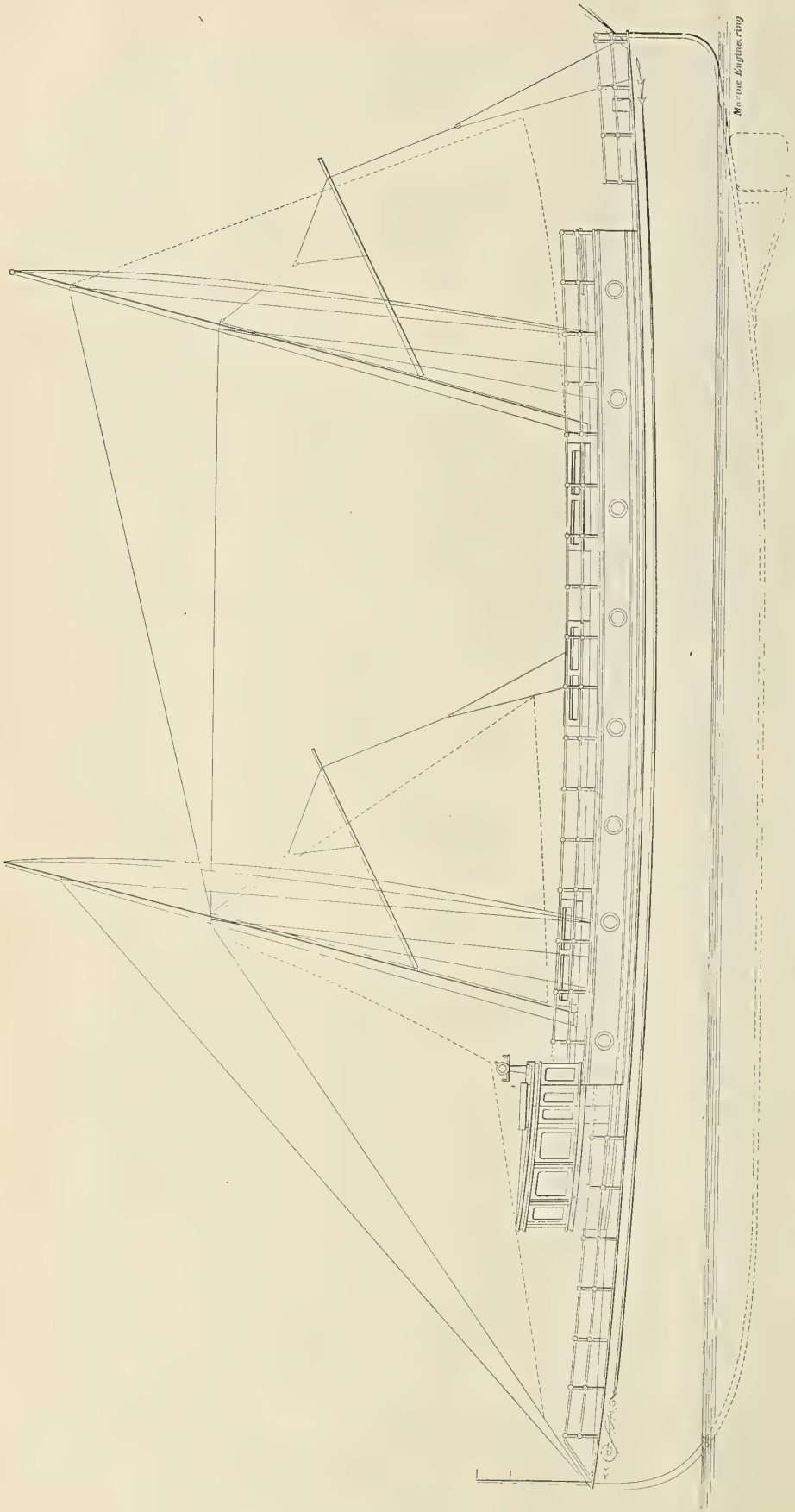
This vessel is 70 ft. long over all, 11 ft. beam, and 4 ft. 2 in. draft, with a gross tonnage of 30.16 tons, and net tonnage of 20.5 tons. She is fitted with twin screws, driven by independent gasoline engines, each developing 30 brake horse power. In design the vessel is intended for service along the Atlantic coast. She has a full bow, easy running lines, with the greatest beam well aft, and a stern of the modified torpedo boat type, thus increasing the water line length and eliminating the tendency to yaw in a following sea. White oak is the material used for the frames, and cedar for the planking, which is double. The under diagonal course is 3-8 in. thick, and the outer fore and aft course is 1 in. thick, with a layer of canvas prepared in beeswax and oil between. Copper fastening is used throughout, and all planking is riveted to the frames over copper burrs. There are two masts, rigged for fore and aft canvas.

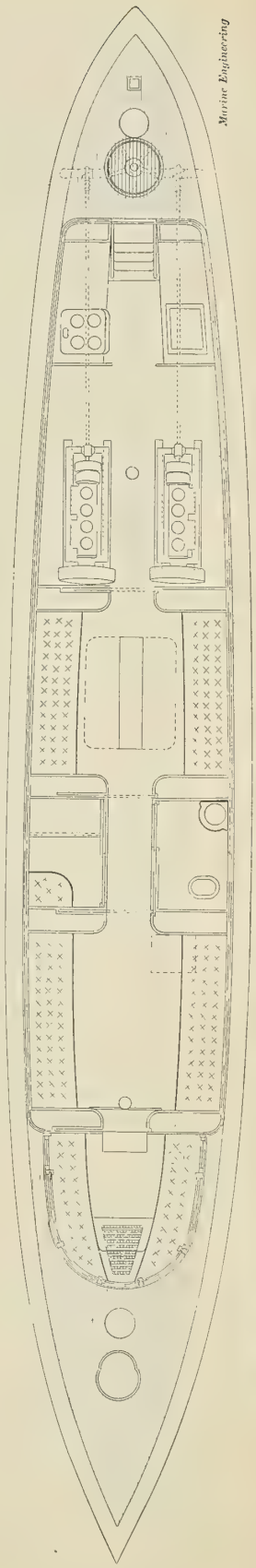
Special attention has been given to the accommodations, the various rooms being handsomely finished and decorated. The main cabin is of solid mahogany inside and out, and is conveniently fitted with closets and lockers. In the forward saloon a stationary desk and bookcase are fitted, and there are large plate mirrors in the doors. On top of the deck house there is an extensive promenade for a boat of this size. Accommodations for a crew of four men are provided. The forecastle is fitted with folding bunks to accommodate three, and in the lazarette two men can be berthed if need be.

Plumbing work has been carried out with special care. There are four lavatories and three Sands water closets fitted, and a bathtub with hot and cold water

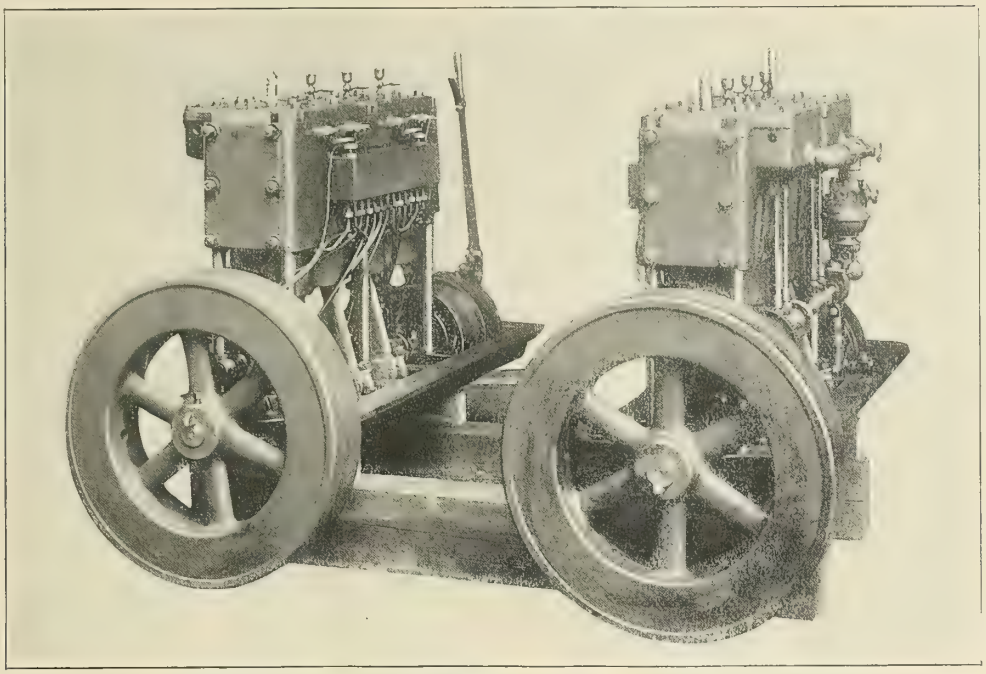


STEEL FLOATING DOCK OF 17,500 TONS CAPACITY AT SHIPYARD OF BLOHM & VOSS, HAMBURG, GERMANY.—S. S. PRETORIA, 12,500 GROSS TONS, ON THE DOCK.—SEE PAGE 150.





SAIL AND ACCOMMODATION PLANS OF THE 70 FT. TWIN SCREW GASOLINE YACHT LADY FRANCIS, OF BOSTON.—CONSTRUCTED AT DETROIT, MICHIGAN.



FOUR CYLINDER GASOLINE ENGINES FOR YACHT LADY FRANCIS.

fittings is placed under one of the extension bunks in the forward saloon. The main water tank is located amidships, under the floor, and there are two supplemental tanks at the stern. Hot and cold water is also supplied to the galley sink.

Two four cylinder self-starting gasoline engines are coupled to the screw shafts in the engine room aft. They are of the marine type, designed by the builders of the yacht. When starting the initial impulse in each engine is given by a powder cartridge, which is slipped into a receiver on one of the cylinders. Exhausts from the engines are carried below the water line, so that objectionable noise and odor are got rid of. Each engine is equipped with an air pump, which supplies air to a tank under a pressure of 55 lbs. per sq. in. The compressed air is used for a chime whistle and siren, operated from the pilot house. Separate engine telegraphs of the dial and pointer pattern are fitted in the engine

TWIN SCREW GASOLINE YACHT LADY FRANCIS READY FOR LAUNCHING.

room, the pilot house, and the upper steering platform. There are also speaking tubes, telephones, and call bells throughout the boat for purposes of communication.

In the engine room a two horse power gasoline engine is direct connected to a dynamo. The circuits are arranged so that the current can be supplied direct to the lamps and search light or to charge a storage battery, the batteries being placed under the floor. Small electric lamps are fitted to light the telegraph dials and the binnacles, and deck plugs and extension lamps are provided for deck use. The gasoline tank has a capacity for sufficient fuel to last on a thousand mile run.

Steel is used for the propeller shafts, and these are fitted with bronze sleeves. The wheels are of bronze also, and are four bladed, 34 in. dia.

Two boats are carried; one 14 ft. dinghey on the starboard side, and one 14 ft. motor boat, with 1 horse power engine on the port side.

Both the hull and machinery were designed by Charles B. King, of Detroit, Mich., and the vessel built by the Charles B. King Co., of that city.

COMMUNICATIONS ADDED TO THE DISCUSSIONS OF PAPERS AT MEETING OF S. N. A. & M. E.

In the seventh volume of Transactions of the Society of Naval Architects and Marine Engineers, just issued, there are interesting additions to the discussions on several of the papers read at the last meeting. These were in the form of communications received too late to be presented at the meeting. Our readers will recall the extensive report of the proceedings which appeared in our issue of December last and in which abstracts of the various papers were presented, together with the gist of the discussions. To complete the latter therefore, we now reprint such of the communications as do not appear in our original report of the meeting. They contain additional information of value and side lights which help to a better understanding of the subjects treated.

WATER TUBE BOILERS.

One of the most interesting papers offered at the meeting was that of Engineer-in-Chief George W. Melville, U.S.N., narrating the "Causes for the Adoption of Water Tube Boilers in the U.S. Navy,"[1] and it was one that especially lent itself to discussion. As the author was not present in person at the meeting, his response to the queries and criticisms of members was among the later communications, as follows:

Rear-Admiral Geo. W. Melville, U. S. N.:—"In the case of the bulging of the steam drums of the *Nashville*, referred to by the first speaker (Horace See), I regret to say that, having at the time perfect confidence in the designs presented by him, for the contractors for the *Nashville*, I accepted them, as submitted, notwithstanding the fact that the steam drums of this particular type of water-tube boiler were discussed in my office and objected to on account of being unprotected.

"Coming to grief by this equipment of boilers, I had nothing else to do than make good the defects as well as I could, and so protected the steam drums by brickwork after the damage was done.

"I remember distinctly, at the time the exposed steam drums were under discussion, it was suggested that a little heat on the steam part of the steam drum would be a good thing, as it might superheat the steam.

"However, the fact remains the same, that the boilers were built in exact accordance with the plans and specifications of the designer, though, of course, this fact does not absolve me from the responsibility for accepting a defective design of boiler.

"Regarding the remarks of George W. Dickie concerning the statement that the *Monterey* had made a run of 8,000 miles, practically under forced draught, and his own statement that the *Monterey* carries but 200 tons of coal, I would say that the ship was driven from port to port where the coal pile was available, and that the ship was driven at as near full power and speed as it was possible to drive her with the limited number of engineers, firemen, and coal heavers—and for no other reason than to satisfy the Department that the ship's engines, and particularly the boilers, were or were not a failure; and the fact is that the water-tube boilers came out of this ordeal unscathed.

"It is true, as stated in the discussion, that the Scotch boilers are used for harbor purpose, and were designed and intended for that purpose, and it should be known that the back connection sheets were badly bulged on the original trial trips before the ship was commissioned, and that the harbor duty had nothing to do with the bulging of the sheets referred to. This is probably a shop secret that is not supposed to be divulged, but the whole of the Navy knows it, and a great deal of the engineering world, so I am not telling tales out of school.

"After the *Monterey's* return from South America, the back sheets were found more badly bulged, and many stay bolts leaking.

"Again, in speaking of the large amount of repairs done to the water-tube boilers, it is true that many of the tubes have been removed; in fact there is no trouble about removing the tubes without disturbing the efficiency of the ship.

"But my good friend again begs the question by neglecting to state that the *Monterey* has already had two sets of tubes for Scotch boilers.

"Regarding reducing valves, we can all very readily see why contractors would like to get rid of reducing valves simply on the score of cost and expense of putting them in. Yet we find the necessity for reducing valves not only in tubular boilers but in our good old Scotch boiler too; and though it may not be considered good engineering to carry a higher pressure in the boilers than we do at the engines, yet we seafaring men at times find it a necessity.

"No one can be so obtuse, if he should try, as not to understand what is meant by 'tactical advantages' of water-tube boilers. Mr. Dickie answers his own question when he says that he supposes that the 'tactical advantages' mean the facility or rapidity with which steam can be raised, and I am sure that he will acknowledge that there cannot be many tactics with a *steam* ship without steam. In fact the whole possibility of mobility and steering qualities at all depends upon her boilers, be they Scotch or water-tube.

"It is not necessary for me to remind any one that the cardinal principles of water-tube boilers have been large heating surface, small amount of water, and the rapid

[1] This paper was reproduced in our issue of January, page 2.

raising of steam ready for instant use, as has been the case for fifty years in the steam fire-engine and other quick steam-generating boilers."

SHEATHING STEEL VESSELS.

Owing chiefly to the little practical experience had on this side of the Atlantic with the sheathing of steel hull vessels, there was no oral discussion of the paper on the sheathing of the U. S. S. *Chesapeake,* by Naval Constructor Lloyd Bankson.[2] Following is the written discussion from the Transactions:

WILLIAM A. FAIRBURN:—"The *Chesapeake* is an interesting vessel because she is the first sheathed vessel built in America, and the world's pioneer sheathed sailing ship. For years Naval Constructor Hichborn, Chief of the Bureau of Construction and Repair, has advocated sheathed and composite vessels, and it is very gratifying to know that at last his persistent efforts and untiring labors are bringing forth fruit. The building of gunboats Nos. 10 to 15 of composite construction four years ago was the entering of the thin end of the wedge. The *Chesapeake*, a sheathed ship, followed in 1898, and this month we have seen contracts awarded for six sheathed 3,400-ton cruisers of great fighting and sea-keeping power. It is rather strange that the first American sheathed vessel should be a small boat with a length of only 175 ft., and a displacement, deeply laden, of less than 1,200 tons. The minimum size of a sheathed vessel is usually considered about 2,500 tons to 3,000 tons, and some authorities state an even larger displacement as the minimum for a sheathed warship. In small vessels, such as gunboats, the weight of hull that can be allowed in a design necessitates eliminating the steel shell below water when the vessel is to be wood planked, and therefore a small planked vessel is always a composite and not a sheathed vessel. The *Chesapeake* is, however, a sheathed and not a composite vessel. She has a steel shell as heavy as any gunboat of her size afloat, and, besides this, she is planked with 4-in. Georgia pine up to about 19 ft. 6 in. draught.

"This sheathing is very heavy for a boat of her size, the total finished weight coppered being about 80 tons, and this thickness of 4-in. should not be taken as a basis in determining the thickness of planking in any future designs. The only reason that I can think of for using such heavy plank on such a small boat is the utilization of the displacement by weight of hull. In the design of a sailing ship like the *Chesapeake*, there is practically no machinery or coal to allow for, and as these weights are very much greater than the increased weight of spars, sails, and rigging, there is a certain margin of displacement and if the draught and co-efficient of fineness is fixed, the weight of the vessel must be increased either by ballast or increased weight of hull. The *Chesapeake* has been designed to carry about 100 tons of ballast, and the surplus weight, I suppose, has been put into the hull, for it is undoubtedly very heavy.

"The builders of the *Chesapeake* followed closely the specifications, which were very complete, during the construction of the vessel, and the specifications for sheathing quoted in Mr. Bankson's paper are but skeleton specifications or a grouping of the more important clauses copied from those of the Department. There were, however, a number of cases where it was deemed desirable to make slight changes, the method of boring the holes through the planking, and the securing of the same, being by far the most important. The fastening of the heavy teak keel was not considered sufficient, and 1 3-8 inch bolts had to be substituted for 1 1-8 inch. I am of the opinion that the width or siding of the *Chesapeake's* keel, 16 in. is not sufficient, considering the great molded depth of 26 in. and the angle of dead-rise. It proved to be a difficult matter to locate the fastenings, and get good bearing for the nuts on the inside of the ship, without boring through the rabbets of the garboard strake and coming too close to the outside of the keel. The deep curved garboard I do not consider practicable, and the builders obtained good results by working a thick garboard strake and gradually reducing the thickness, working into the mean thickness of 4 in., in four strakes of bottom planking.

"By boring the holes through the planking from the outside of the ship after it is secured in place, the prospects for getting holes square with the shell are much better than if the plank is removed and drilled on the ground or staging. By this method the plank has to be steamed but once, whereas if the plank is fitted in place and then taken down to be bored a second steaming is frequently found necessary, and the holes bored in the plank are quite often found to have quite a perceptible angle to the shell instead of being normal to the surface. If through carelessness a hole is bored through the planking on an angle, and not normal to the surface, it is much better to drill and tap through the plating on the same angle and use a tapered washer on the inside than try to rectify the evil by endeavoring to work the steel drill square and therefore elongate the hole in the plank. I have seen the latter insisted upon by inspectors, but I have not been able, as yet, to see the logic of it.

"A vessel could be planked by the method adopted on the *Chesapeake* without a single bolt coming on longitudinal vertical bulkheads or any other similar obstructions. Over 9,000 bolts were used in sheathing the *Chesapeake* and only one or two came through the shell in inaccessible places and where washers and lock nuts could not be fitted. Very intelligent men are necessary, however, to locate the fastenings of a sheathed ship. The planking should all be laid out on the vessel's bottom before the work is commenced. Then, as the planking is worked from the garboard up or from the sheer margin down, measurements should be taken from the fastening of the last secured strake for the location of holes in the next. The inside of the vessel should be inspected and these measurements checked before boring, for with plank 8 or 9 in. wide there is quite a good leeway for locating bolts. The riveting of the shell also tells quite a story, and an intelligent ship carpenter can soon be schooled to understand not only where the laps and frames are, but where the longitudinal bulkheads, buttstraps, bulkhead liners, etc., are.

"All wood ships leak, and it is impossible to build a composite or sheathed vessel that will not let some water through the plank. It may come through the seams or through defects in the plank, the bolts may leak, and some water may soak through the plank, but no builder of wood ships can keep all water out of his vessel. The leaking of a well built, well calked, com-

[2] This paper was published in our March issue, page 100.

posite ship is slight, and usually a matter of small importance, not being worthy of consideration. But every ship-builder probably knows the detrimental effect of salt water lodging between a steel hull and wood planking. If there is any space between the steel hull and planking of a sheathed vessel, water will find its way there and soon occupy it, in spite of all precautions taken to prevent it; therefore, it is quite apparent that the only way to prevent water occupying these small spaces is to fill them up with solid matter. It is impossible to lay plank against a steel hull and secure the same so that the two materials are so compact and close together that there is no space for water between them.

"The specifications of the *Chesapeake* called for a mixture of 200 lb. of red lead, 100 lb. of white lead, and 3 gal. of linseed oil well ground together, to be injected, by a suitable force pump, into holes bored in the middle of each plank about 8 ft. apart. It was required that these force pumps have relief valves loaded to 10 lb. per sq. in. pressure. A mixture of the density specified was prepared, but it was so thin that it had to be ladled. The amount of oil was finally reduced somewhat, but still the results, whilst in accordance with the specifications and the Superintending Constructor's wishes, were not very satisfactory. When first tried, I venture to say that the men got more of the red lead on their overalls than the ship received. The pressure of 10 lb. per sq. in. is much too small for work of this class, and when it is stated that this pressure is fixed so low to avoid forcing apart of the planking and plating, I think the whole thing should be treated as a good joke, for twice or even two and a half times this pressure would not prove excessive.

"After seeing the red lead injected into the space between the shell and plank of the *Chesapeake,* I cannot help but contrast it with the method which I have frequently seen of filling up the space between the armor-backing plates and the wood-backing of armor clads. I have worked a red-lead force pump myself, and my experience is that the operator can always feel his pump and tell when it has had enough. A much thicker composition should be used, for the putty softens and limbers up a good deal in working and when in the chamber of the pump. When the operator feels that the hole his pump is discharging into has received sufficient matter, a rest of a few minutes will often convince him that this is not the case, for the material travels, and he should continue to force the composition in until, on removing the pump, a little while after the last discharge, the putty flows freely from the hole. I am strongly of the opinion that the injection should be made from the inside through the steel shell wherever practicable on a sheathed ship. The plank should also be well bedded in thick red lead when laid. On the bottom the putty could be put very thickly on the inner face of the plank before it is put in place, and on the sides the shell could be well covered before the plank is forced into position.

"I do not consider that 3-4 in. brass bolts, which have an effective diameter of only 5-8 in., are large enough, as usually spaced, to secure 9 in. by 4 in. Georgia pine plank to a 3-8 or 7-16 in. well stiffened steel shell. The bearing surface under the heads of planking bolts is generally made too small, and the size of the heads of such bolts should be increased to avoid injuring, crushing, and splitting the plank when setting up. The countersinks over the bolt holes on the *Chesapeake* were plugged with Portland cement as per the specifications, which treatment agrees with the usual foreign naval practice, but I fail to see the advantage of this, and in many respects I think a pine plug is preferable, for my experience is that it insures better water-tightness.

"I would also suggest making the shell below the planking line, on a vessel like the *Chesapeake,* carvel-plated or flush, instead of the usual in and out strakes. I do not know of any scientific or practical reasoning that would condemn, on a vessel of this class and size, the use of single-riveted seam straps—the *Chesapeake* has double-riveted plate edges—therefore by making the plating flush the riveting would not prove more troublesome for wood-fastening, and it would simplify laying plank. Some of the largest foreign built sheathed vessels have but single-riveted plate edges below the planking line. If it is desired to reduce weight, what would be the objection to making the seam straps intercostal between frames, thus eliminating all liners? The edge strips have a very small area, and are not strapped, therefore they do not contribute much to the strength of the ship, and if found desirable special liners could be placed at the water-tight bulkheads—the ship's weakest section for fore and aft bending.

"The model of a sheathed ship should be especially adapted for planking. Bath sailing ships, for half a century, have been designed with this object in view. The Bath wood shipbuilder's planking lines are the modern naval architect's diagonal lines, and this fact throws some light on the fact that Bath ships have been known throughout the world for fast sailers. The *Chesapeake* has a midship section that in some respects resembles the old clipper ships, but she has steamship underwater ends and the stern is particularly bad for sailing qualities and also for planking."

Naval Constructor W. J. Baxter, U. S. N.:—"As is well known, every endeavor must be made to prevent the presence of free salt water between the faying surfaces of steel skin plating and wood sheathing, which is covered and fastened with copper or some of its alloys. The wood sheathing should be elastic, durable, non-corrosive, and free from knots, splits, checks, or other defects which will allow salt water to filter through it.

"Yellow pine is not elastic, and it is therefore very difficult to insure the sheathing bolts being sufficiently compressed into the planking to prevent leakage under their heads; this material also contains splits and checks, which can only be found by the most minute inspection, and also frequently contains knots, all of which defects will cause leakage.

"In my opinion, teak is the best material now known which is suitable for sheathing. It is elastic, durable, non-corrosive, non-absorbent, contains few knots, and any worm holes or splits can be discovered by ordinary careful inspection.

"When salt water has once found its way behind the sheathing it is important to localize it, rather than to permit it to flow fore and aft; it is therefore of vital importance that the oakum in seams and butts should be hawsed home to the skin plating, thus reducing to a minimum the volume of those interstices which inevitably occur between the plating and the sheathing, so that salt water which may leak through any particular plank or planks, from various causes, shall be prevented

from spreading over the entire bottom. This method will also enable the red lead filling to be much more efficiently injected behind the planking, the injecting holes being spaced from 3 to 4 ft. apart on each strake of planking, commencing about 6 in. from the butts.

"Even under the most favorable circumstances water-tightness cannot be secured except by constant and minute supervision of all work on the bottom, afterwards removing planks, here and there, to ascertain the condition of the calking, filling and fastening, not otherwise visible."

Naval Constructor Lloyd Bankson, U.S.N.:—"The writer of this paper regrets that no discussion followed its presentation.

"It has been found, after docking and examination of the *Chesapeake*, after the date of the meeting at which this paper was presented, that the principal difficulty was in regard to the insufficient amount of putty pumped behind the yellow-pine sheathing. Considerable care was exercised not to injure the planking by too much pressure, and this precaution was carried too far, as an examination in dry dock showed that the spaces between plating and planking were not completely filled. Boiled linseed oil was used in making the putty pumped between the sheathing and the bottom plating. It is thought that thin putty can be used to advantage without the use of relief valves on the pumps, if careful and experienced men are employed at this special work.

"It is hoped that the *Chesapeake's* sheathing will be carefully examined at frequent intervals, in order to obtain all the practical information possible in regard to this class of work, and it is suggested that a number of 3-8-in. holes be drilled and tapped in the outside plating, below the water-line, from the inside, and closed with square-headed bolts, so they can be removed from time to time, while the ship is afloat, to determine if water has found its way behind the planking."

DENVER CLASS OF CRUISERS.

In the paper on the *Denver* class of sheathed protected cruisers by Chief Constructor Philip Hichborn, U.S.N., it will be remembered that references were made to the U. S. Ss. *Raleigh* and *Cincinnati*, which called forth responses by Engineer-in-Chief George W. Melville, U.S.N., and others in the discussion. It was thus brought out that the disproportionately large power put into these vessels was decided upon to satisfy the public demand, at that time, for ships which would equal in speed those being built by foreign navies—notably the British. Now the Chief Constructor in closing the discussion says:

Chief Constructor Philip Hichborn:—"The discussion does not appear to call for any detailed rejoinder. With reference to what has been said by various speakers about the *Raleigh* class, an examination of these remarks simply confirms my very moderate statements. They somewhat fully elucidate the 'well-known conditions' to which I referred.

"I have always regretted that the *Cincinnati* and the *Raleigh* were not given complete trials, such as would have been given had they been built by contract. Soon after their completion I urged this upon the Department, but other officials interested opposed my recommendation, and the trials were not made.

"With reference to the four-hour trial of the *Raleigh*, the displacement at which it was made is somewhat greater than the designed displacement, but this is largely accounted for by the fact that the finished weights of her machinery materially exceeded the estimated weight upon which the design was based. The quoted average speed is stated to be 18.64 knots, while during two hours of that time the average was 19.27 knots. A simple arithmetical calculation will show that for the other two hours the average was but 18.01 knots. It is not questioned that the *Raleigh* will be able for a short spurt to touch her rate of 19 knots, but it appears that after two years in commission, during a four-hour trial, she reached a speed of 19.27 knots for two hours, and only 18.01 knots for the other two hours. This seems to confirm my very mild remarks as to the maintained speed of the *Raleigh* class. It would have been interesting had the indicated horse-power maintained during this four-hour trial been quoted as well as the speed. So far as my information goes, the estimated horse-power of these vessels has never been approached in any trial, much less maintained.

"A change which has recently been authorized upon the *Cincinnati*, the sister ship of the *Raleigh*, includes the reduction of the nominal boiler power from 10,000 to 7,200, new high-pressure cylinders being fitted of smaller diameter. Concerning this change, the Chief of the Bureau of Steam Engineering, in his annual report, says:—'Undoubtedly the result, while reducing the rated speed of these ships, will really increase the speed that can properly be maintained and will greatly add to the efficiency of the vessels.'

"I think I can quote no stronger confirmation of my statement that the *Raleigh* and the *Cincinnati*, as at present arranged, have never been able to maintain a speed even approximating to the rated 19 knots for any length of time."

TORPEDO BOAT DESIGN.

Few subjects invite discussion so readily as torpedo boats. Many members present at the meeting participated in the discussion of the paper on "Tactical Considerations Involved in Torpedo Boat Design," by Lieut. A. P. Niblack, U.S.N.,[3] and to this is added the following communication:

William A. Fairburn:—"I am somewhat disappointed in Lieutenant Niblack's paper, for I had expected to read something new and original—facts gleaned by sea experience, and convincing arguments advanced by one who has the reputation of being not only an able naval officer, but a torpedo-boat expert. The paper before us is, however, nothing more than a *tout ensemble*, a massing together of Lieutenant Niblack's remarks and sweeping statements which we have heard and read during the past two years.

"Although it is a fact that almost any shipyard to-day, without traditions or previous experience, seems willing to take the contracts for high-speed torpedo-boats and destroyers, yet upon strict scrutiny we find that such firms almost invariably have in their possession plans of successful similar boats, and instead of branching out, taking great risks, and thereby courting disaster, they seem perfectly contented to follow in beaten tracks and

[3]This paper was reproduced in our issue of February, page 57.

in the footsteps of some successful torpedo-boat builder. The new successful torpedo-building firms—whether they be new firms just springing up, without any building experience, or old established firms now branching out into light construction—will be those who are now following the plans of such builders as Thornycroft, Yarrow and Normand, and the few firms which in some respects are apparently original, breaking away from old traditions and making innovations, will probably discover by bitter experience that a speed of 28 or 30 knots, although lightly spoken of to-day, is nevertheless a difficult proposition, and cannot be attained without gradual steady progression. If a firm is not willing to profit by another's experience, it must of necessity go over very nearly the same ground that other firms have traversed, and meet evils and discouragements of a similar nature to those that they have encountered and overcome in the past.

"I think that the shipbuilders who contracted to build torpedo-boats and destroyers from the United States Navy Department's designs fifteen months ago exhibited a great amount of courage. Such firms are bound down and limited on every side; they take a great deal of responsibility, and the most optimistic cannot feel confident of satisfactory results and probable success. The contractors, most of whom, however, are inexperienced firms, guarantee results without voice in the matter, and therefore exercise a blind, unreasonable faith in the Department's ability to design successful torpedo craft. Other governments, with great experience in torpedo-boat construction, and with navies containing hundreds of these little craft, have not as yet considered it advisable to prepare their own designs. I think, therefore, that it is poor policy for the United States Navy Department to attempt designing before they have had experience with various types of these vessels. There are many types of successful torpedo-boats, but when a compromise is attempted and the so-called good features of all are embodied into one design the results are usually disastrous.

"Lieutenant Niblack lays great stress upon the fact that high speed is not necessary or even desirable in torpedo-boat construction. Naval authorities, the world over, will differ with him in this broad assertion. Speed is the torpedo vessel's only protection. On a dark, thick night a torpedo-boat can steam within striking distance of a war vessel without being seen or heard on board the latter vessel. This has often been done, and, under certain atmospheric conditions, the searchlight is valueless, noise is deadened, and picket-boats and torpedo-nets are the only efficient parts of a war vessel's torpedo defense. On a clear night sound travels, and noise of any great intensity can be heard for miles at sea. Under such atmospheric conditions it is probable that the racket and dull thud of a torpedo-boat's machinery could be heard for some little distance, flames shooting from the stacks would be soon discerned, and the search-light, working under most favorable conditions, would probably locate without difficulty the on-coming torpedo-boat.

"It appears, then, that on a clear night, when the conditions are most unfavorable for torpedo-boat attack, noise and flame should be eliminated as much as possible, if the torpedo-boat attack is to prove successful. The blowers, run at high speed in order to obtain great air pressure in the fire-rooms, are the cause of almost all the noise on board a high-speed vessel, therefore a torpedo-boat should crawl up on the enemy under natural draught or with the blowers running very slowly. The fires should not be too thick on the grates, and under natural draft or a slight air pressure, with thin, carefully laid fires, no flames would shoot from the stacks to herald the vessel's approach. I do not think that flames pouring from the stacks need be considered in torpedo-boat design, for my experience is that thick, heavy fires and great air pressure are responsible for this disagreeable feature so detrimental to torpedo-boat attack. The amount of smoke pouring from the boat's stacks should be reduced to a minimum, but the quality of coal used is responsible primarily for the volume of smoke discharged from the stacks, although the air pressure has a great deal to do with it.

"Under the most unfavorable conditions for torpedo-boat attack, a torpedo-boat will probably steam a good distance within a war vessel's zone of secondary battery fire before she is discovered. Speed under natural draft, or easy steaming conditions, is therefore of great importance in a torpedo-boat, for the period that she is running the risk of being destroyed depends on the vessel's easy steaming speed for a good part of the time, and when once discovered the sooner the vessel's speed can be increased to the maximum, and the faster the vessel can steam, the less time she will be within range of the enemy's guns. The speedier the attacking boat, the sooner, therefore, she can get within striking distance of her prey, and the quicker she can steam beyond range of the emeny's guns. A 22-knot torpedo-boat cannot steam at a speed of 20 knots or more under natural draft, as Lieutenant Niblack would seem to imply, but to attain this speed she must run under forced draft and speed the blowers, which means make as much noise as the 30-knot boat would make at 27 or 28 knots speed. If the slower torpedo boat steams up to her adversary under natural draft, it will take her about as long to pass from a natural-draft speed to her full speed of, say, 22 knots as it will take a 30-knot boat to increase from 20 to 22 knots up. A torpedo-boat will be in range of the enemy's guns for a certain period of time that depends wholly on the vessel's speed, providing she is not disabled. Therefore the protection of a 30-knot boat compared with that of a 20-knot boat is in the ratio of three to two.

"I have seen more flame shooting from the stacks, more water commotion, and heard much more noise on a high-speed torpedo boat of 25 or 26 knot speed than I have ever seen and heard on a boat steaming at a speed of 30 to 31 knots, and from reports that I have received it appears that our 22 to 24 knot boats make a great deal more fuss and noise at this speed than our latest torpedo-boats make at a speed of 30 knots.

"Lieutenant Niblack asks if a 30-knot boat can pass from a speed of 20 knots to 30 knots in a period of 30 seconds. A well-designed, 30-knot torpedo-boat could steam quietly under natural draft at a speed of from 20 to 22 knots per hour. If the order should be given for full speed ahead, the blowers could be started in the fire-rooms immediately at full speed, and if the risk of getting a little water over from the boilers into the engine cylinders is accepted, the little vessel could in half a minute be ploughing through the water at approxi-

mately her maximum speed. I will admit, however, that the gradual speeding of the blowers, and therefore the gradual rise in speed, is by far the best for the light, quick-running machinery, but, nevertheless, if speed has to be raised rapidly, it can be done, for it has been done on several occasions to my knowledge. I have frequently been on board a 140-ton boat of this type that steamed quite easily with open stokehole, and the blowers running slowly at a speed of 25 knots per hour at sea.

"Three years ago, whilst in Scotland, it was my good fortune to watch the construction of a number of torpedo craft building at that time on the Clyde for the British and foreign governments. In quite a number of cases the boats building for the foreign governments had to undergo a measured mile test full speed astern. If I remember aright, a speed astern equal to two-thirds full speed ahead was guaranteed by the builders, and in every case slightly exceeded. A number of naval officers, representing the navies for which the vessels were building, frequently expressed the opinion that the best way to attack a war vessel with a torpedo-boat or boats is to steam rapidly toward the enemy, bows on, so as to offer as small a target as possible to the shot, reverse the engines, discharge the torpedo from forward, and steam out of range of the enemy's guns, full speed astern, before turning a broadside to them.

"The arrangement of torpedo tubes on American boats is, in my opinion, crude and most inefficient. The stern tube, to which the Bureau of Ordnance fondly clings, cannot be fired when the vessel is under way, and it is therefore practically valueless. The midship tubes are undoubtedly desirable and necessary, but when using these guns the torpedo-boat presents generally a full broadside as a target for the enemy's rapid-fire battery. It is well to note, however, that when a boat is steaming full speed ahead, the tubes located near midships are the only ones that can be used with probable success. Although the bow torpedo tube is not in favor in this country, yet there are times when such a tube would prove of great value. Foreign naval officers appreciate this fact and 90 per cent. of torpedo-boats in the navies of the world are fitted with bow tubes. The only argument against them that I have heard advanced is the danger of a boat running into its torpedo before the latter has had time to attain its high rate of speed. This argument is not sufficient to warrant condemning the bow tubes in torpedo vessels, for when the torpedo-boat fires its torpedo, after steaming head on to the enemy, the engines could be reversed, and under bells—full speed astern—instead of following her torpedo she could steam as rapidly as possible in the other direction, out of range of the enemy's guns.

"I should like to know why the 3.55m. (short) Whitehead torpedo has been adopted for the later torpedo-boats of the United States Navy, instead of the 5m. (long) Whitehead torpedo, which is generally considered far preferable.

"I agree with Lieutenant Niblack in his remarks concerning the relative merits of single and twin screw boats. Draft and stability have to be seriously considered in this question, however, and I think that they will usually limit the power applied to a single shaft on a torpedo-boat to about 2,000 I. H. P. The bow rudder is a very desirable feature that ought to be adopted in all torpedo-boat designs, especially for second-class inshore and harbor boats. I do not follow Lieutenant Niblack when he says that, in turning, the pivot of our twin-screw boats is almost at the forefoot and a bow rudder would shift the pivot to about amidships, and improve the manœuvring power considerably. The first action of the rudder when it is put over tends to turn the vessel about an instantaneous axis, but when the sideward drifting of the ship becomes equal to the transverse component of the pressure on the rudder, the ship continues to turn about the centre of lateral resistance under the action of the couple-pressure on rudder multiplied by distance between centre of pressure of rudder and center of lateral resistance. If the deadwood of a vessel is cut away aft, the manœuvring qualities of the boat will be much improved, owing to the centre of lateral resistance being moved forward; but although this is a desirable feature as it also reduces somewhat wetted surface and weight of hull, it should be borne in mind that it injures the boat's weatherliness and steadiness in a seaway. The experiments made by Normand with bow rudders prove that with his boats such rudders divided the tactical diameter by two. My experience is that a bow rudder is absolutely essential in a torpedo-boat that has a stern rudder forward of the screws. When steaming at full power it takes but a small angle of helm to make a barn-door rudder interfere with the flow of water to one of the propellers, and at full speeds, with helm hard over, the excessive racing of a propeller wheel brings great stresses upon machinery which must of necessity be more or less delicate. Therefore, although at low speeds a twin-screw sea-going torpedo-boat may be handy and manœuvre well, yet quite often, when the rudder is forward of the screws the helm angle at high speeds is so limited that the tactical diameter of the vessel is much too great. A bow rudder that when not in use can be housed in a well above the line of keel would overcome this evil.

"Lieutenant Niblack advocates building torpedo-boats from identical designs with standardized fittings. This is, in some respects, an excellent idea, provided that we have a type that has given very satisfactory results, and which will stand comparison with the best existing foreign types. But yet this scheme has many disadvantages. If we were to build year after year torpedo vessels of a type standardized by the Navy Department, there would be no incentive for private shipbuilding firms to experiment and vie with each other in the production of first-class, efficient, economical vessels. If it had not been for the untiring efforts of four torpedo-boat building firms, there would be no 30-knot torpedo-boats and destroyers ploughing the waters to-day. Yes, I will go even further, and say that if each government had in the past persisted in standardizing and designing their own torpedo-boats, the successful high-speed torpedo craft of to-day would not be in existence. If torpedo-boat builders were called upon to make fittings for the boats that they have designed and are now building, based upon the average naval officer's idea of what standardized torpedo-boat fittings should be, I would venture to predict that the weight of hull would increase to such an alarming extent that the designers and builders would be compelled to insist upon a reduction in trial speed. I have examined torpedo craft built by inexperienced firms and been astounded at the useless

weight put into detail fittings. The total weight of hull in such boats seemed quite reasonable, but the strength members of the ship had been reduced almost below the safe minimum in order to allow for big ship fittings and equipment. A strong vessel, high speed, and battleship fittings do not go together in torpedo-boat design. The first is essential, and if the last is insisted upon, machinery of less weight and therefore less speed follows.

"If it were not for some very strong remarks made by Lieutenant Niblack at last year's meeting of the Society, I should ask him if a standardized fleet of sea-going torpedo-boats of the *Foote*, *Rowan*, *Davis*, or *Ericsson* type; a fleet of second-class boats of the *Mackenzie* and *McKee* type, and a fleet of vedettes similar to those built for the *Maine* and the *Texas*, would harmonize with his ideas. Personally, I think that it is better to have ten boats all different and three of them successful than to have ten standardized boats all utter failures. But Lieutenant Niblack has gone on record as saying that there is only one firm in this country capable of building torpedo-boats, and he regrets that the Navy Department does not award all the contracts for the construction of these vessels to this firm. The firm in question is undoubtedly a very successful one, by far the best thoroughly original American firm, but a speed of about 28.5 knots on a displacement of approximately 170 tons is its best performance. It has built machinery that weighs 51 pounds per I. H. P., and obtained 23 I. H. P. per square foot of grate. Is it fair to the American builders of torpedo-boats who have produced boats that have attained a speed of 30 knots on a displacement of less than 140 tons, and to builders of a very successful 30-knot destroyer, to say that there is only one firm in this country capable of building high-speed craft? The *Dahlgren's* splendid performance cannot be equalled by any other shipbuilding firm in this country. The builders of this boat have obtained over 4,200 I. H. P. with two water-tube boilers and 35 I. H. P. per square foot of grate. The machinery weighs only 41 pounds per I. H. P., and this small weight has been obtained with a long stroke engine turning up to only 318 revolutions per minute—a piston speed of 1,100 ft. per minute.

"The torpedo boat must of necessity be a refined machine. Mathematics and science must take the place of the two-foot rule and the about-so-much method of proportioning scantlings and details. High-grade material must be used so as to keep the factor of safety reasonably high, with minimum weight. A light, refined machine, however, does not mean a weak, flimsy production. Weight does not necessarily mean strength. Far from it, for there are torpedo-boats afloat that in actual service, if well cared for, will stand as much wear and tear as the average heavily built cruiser. Some of the most rugged, durable, best, and easiest running machinery that I have ever seen has been modern high-speed torpedo-boat machinery."

Charles Fletcher, of Providence, R. I., has placed an order with the Harlan & Hollingsworth Co. for a twin screw steam yacht, 212 ft. long.

A combination on terms of mutual agreement has been effected between the Atlantic Transport Line and the Leyland Line, making a practical consolidation of $25,000,000 capital, and the services of a fleet of 48 passenger and freight steamships.

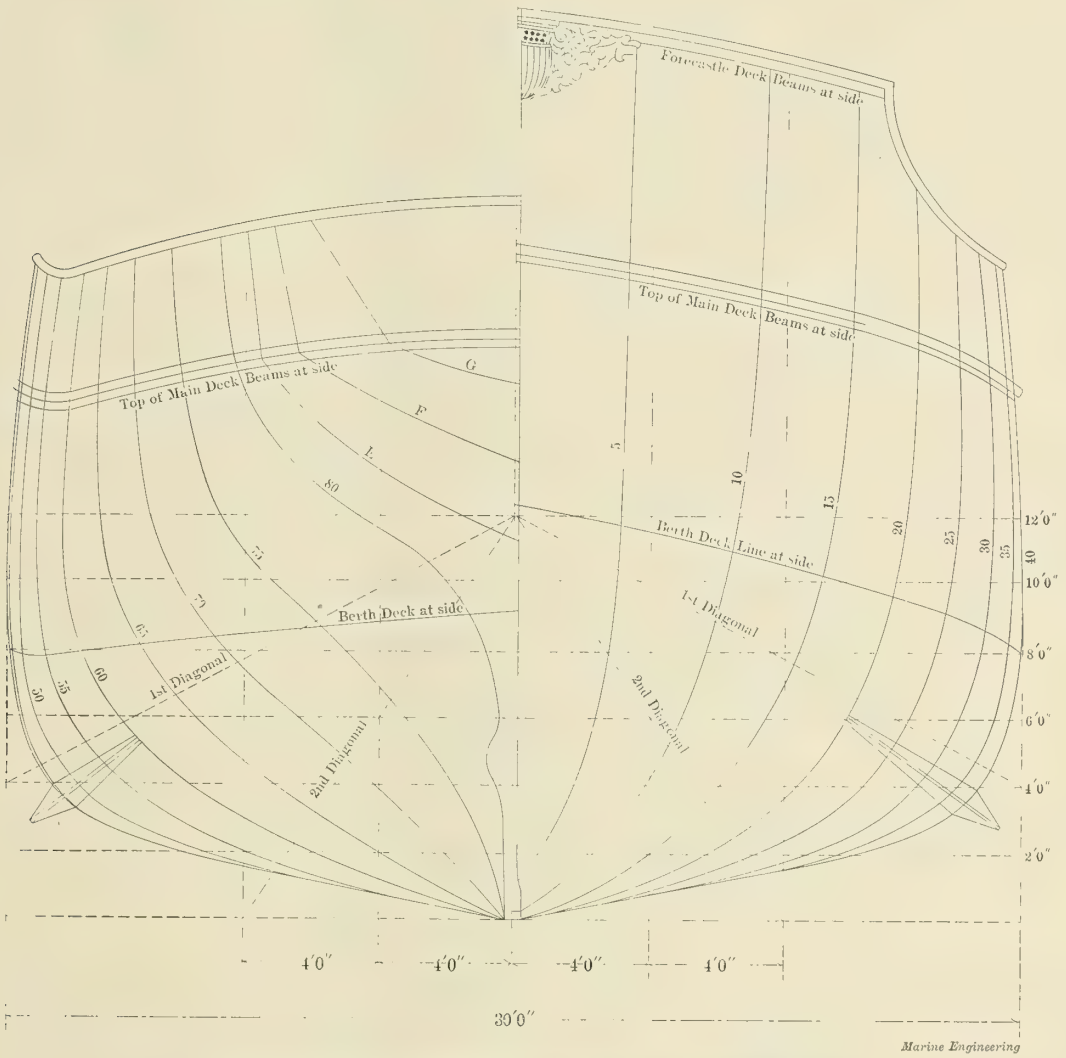
LINES OF THE STEEL SINGLE SCREW U. S. REVENUE CUTTER FOR SERVICE ON THE GREAT LAKES.—SHEER AND HALF BREADTH PLANS.—SEE PAGE 161.

SINGLE SCREW STEEL U. S. REVENUE CUTTER FOR THE GREAT LAKES.

Bids for the construction of a new revenue cutter for the Great Lakes were opened at Washington recently as follows: American Shipbuilding Co., Cleveland, delivery on or before May 1, 1901, $150,000; Chamblin & Scott, Richmond, Va., delivery in 12 months, $163,500; Townsend & Downey, New York, delivery in 12 months, $151,000; William R. Trigg Co., Richmond, Va., delivery on or before May 28, 1901, $157.000. This was the first appearance of the second named bidders in competition.

This firm is composed of John C. Chamblin and James H. Scott, both of Richmond, who have now extensive facilities for engine work, and who, it is understood, are prepared to put in a plant for hull construction if awarded the contract.

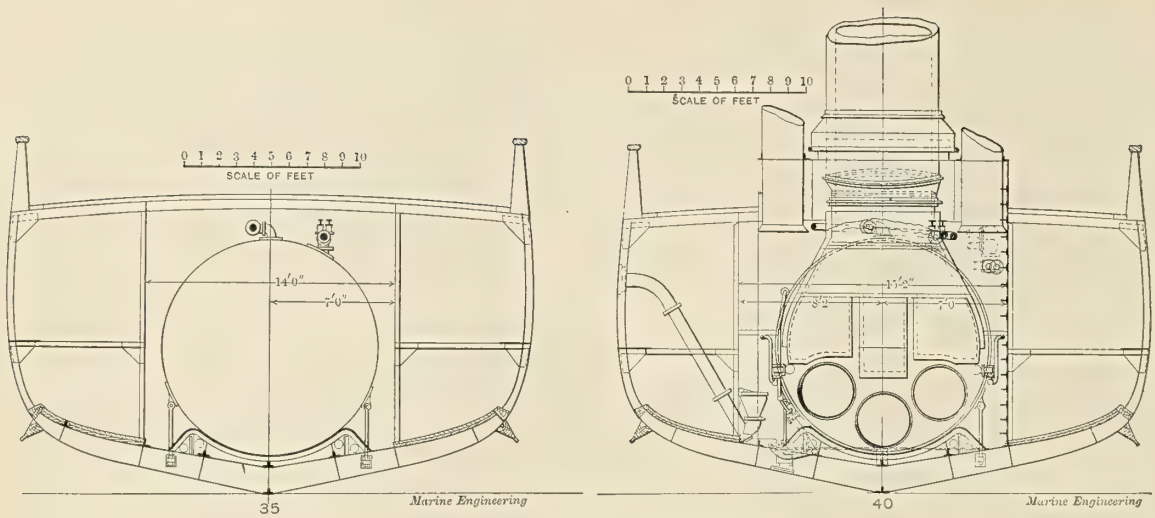
The new revenue cutter is to be a steel single screw vessel of about 620 tons displacement. Her general dimensions are: Length over all, 178 ft.; beam, moulded, 30 ft.; depth, to base line, 15 ft. Captain Russell Glover, R.C.S., superintendent of construction, designed the hull. This will be of mild open hearth steel of a tensile strength of 55,000 lb. per sq. in., with an elongation of 25 per cent. in 8 in. Physical tests to be applied require that the material must withstand bending traversely back on itself without sign of fracture. This grade of material has been found satisfactory in every way for use in the construction of the hulls of revenue cutters. The frames are made of 5 in. by 3 1-4 in. by 3 1-4 in. Z bars, spaced 2 ft. centers and secured to a vertical keel plate



BODY PLAN OF U. S. REVENUE CUTTER.—DRAWN TO ENLARGED SCALE.

of 15 lb. steel, about 21 in. deep. The floor plates generally will be 18 in. deep next to the vertical keel, while in the engine and boiler space they will be extended up so as to form a part of the foundations for the engine and boiler. The outside plating up to the line of the main deck will be of steel 15 lb. per sq. ft. The stem will be slightly ram shaped. The stem and stern post will be forgings of wrought iron.

The hull is divided into compartments by four watertight bulkheads. The quarters for the commissioned officers are located on the berth deck aft of the engine



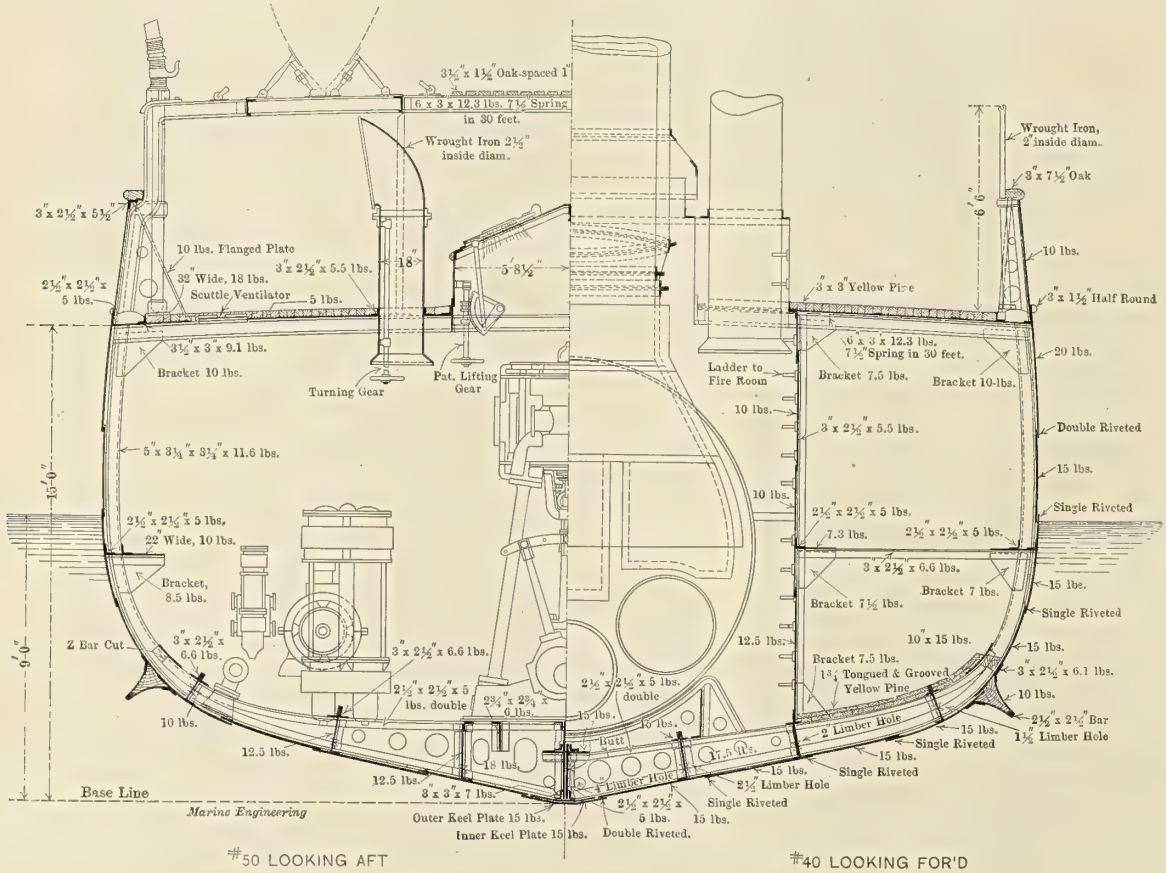
ARRANGEMENT OF MACHINERY OF REVENUE CUTTER.—CROSS SECTIONS AT FRAMES 35 AND 40.

compartment, and the quarters of the petty officers and crew are forward of the boiler compartment. The accommodations for the crew, as well as for the officers, are comfortable, and every care has been exercised to make the conditions of life on board ship as pleasant as possible. To this end the sanitary system of the vessel has been made very complete, shower baths and running water being provided for the crew, and the water closets being continuously flushed.

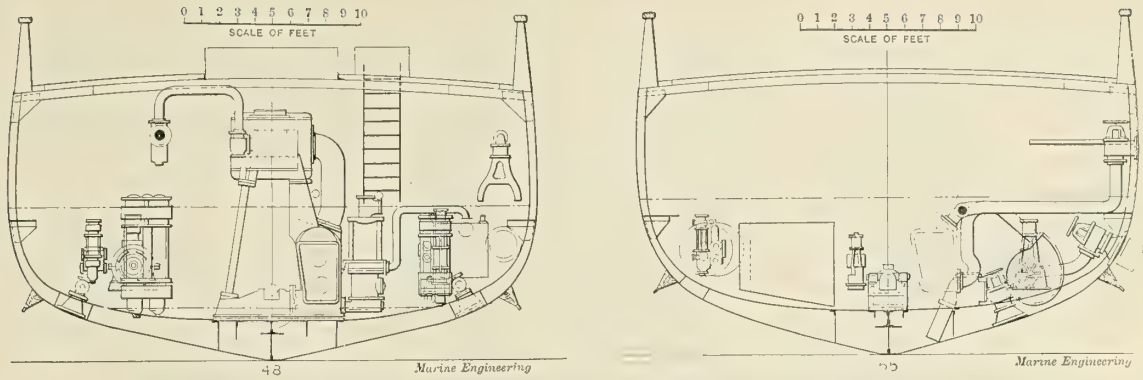
The pilot house and chart room are to be located on the forecastle deck forward of the smoke pipe, and a bridge will extend across the top of the pilot house to the ship's side.

Two bower anchors will be provided, each weighing about 1,800 lbs. They will be secured to 1 1-4 in. stud link chain, provided with shackles every 15 fathoms. The anchors are to be of the stockless type.

Provision will be made for carrying a certain amount



CROSS SECTION OF U. S. SINGLE SCREW REVENUE CUTTER FOR THE GREAT LAKES.

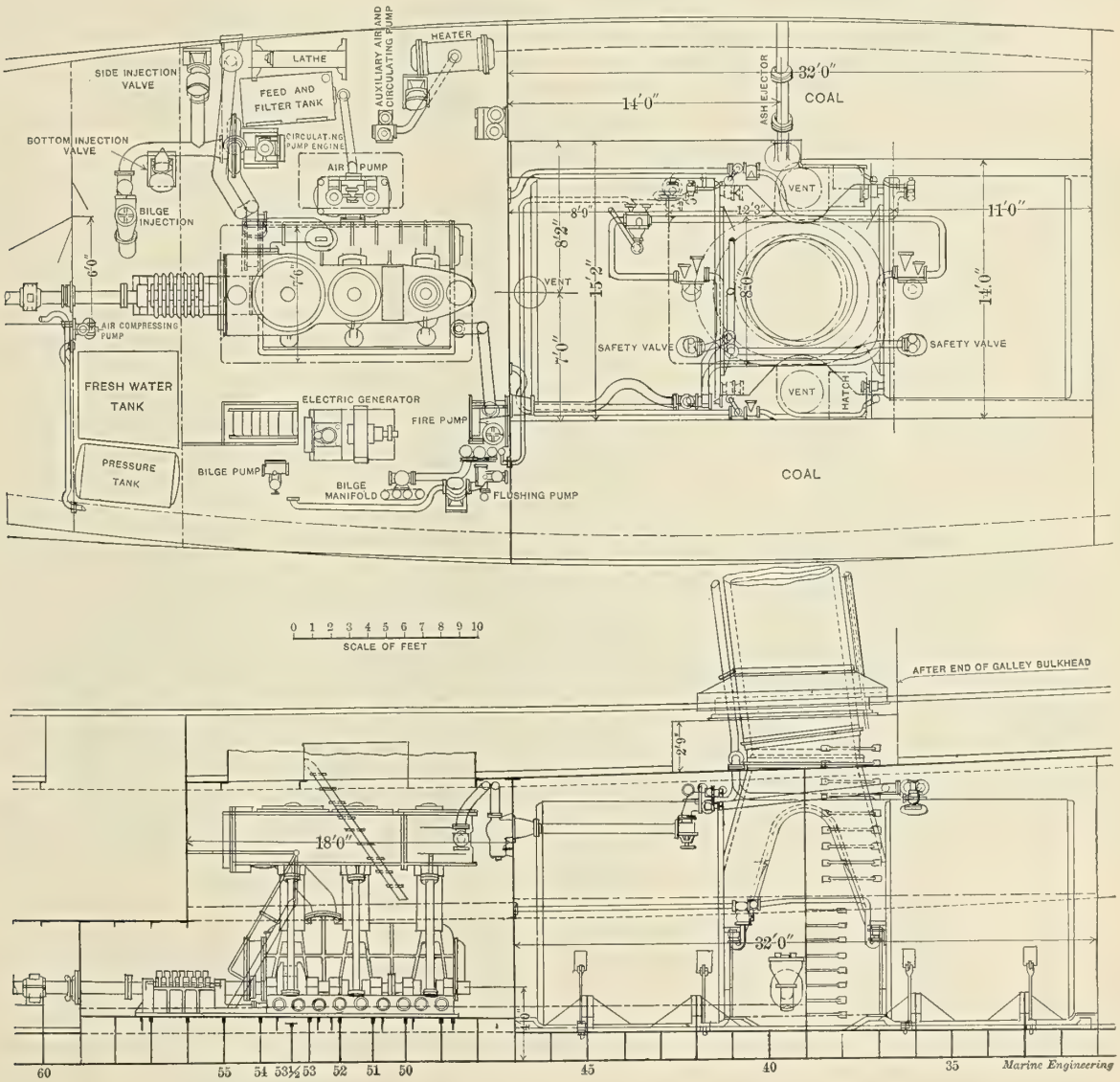


ARRANGEMENT OF MACHINERY OF REVENUE CUTTER.—CROSS SECTIONS AT FRAMES 48 AND 55.

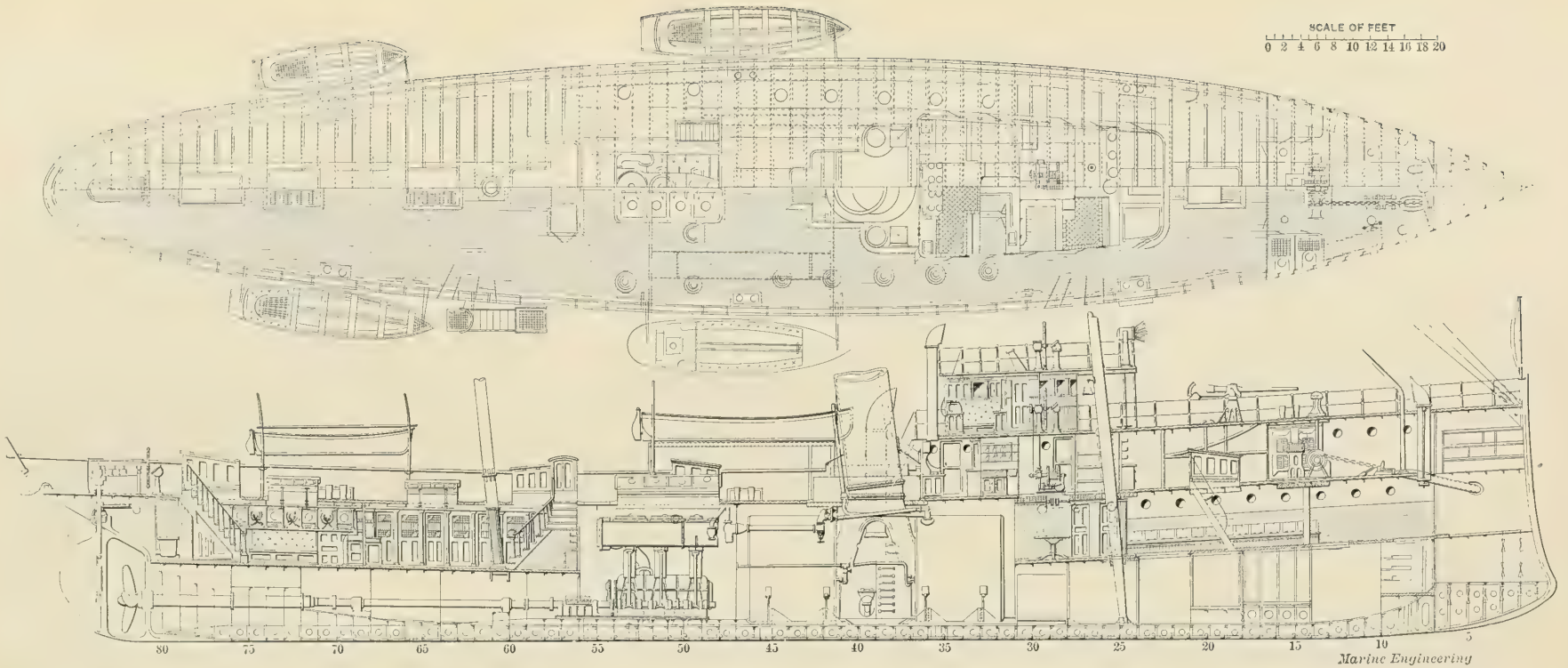
of sail, principally to be used for steadying purposes in a seaway. For this purpose the vessel will have two steel masts, each about 80 ft. high, above the main deck.

The propelling machinery of the vessel, which it is expected will give her a speed of 14 knots at full power, was designed by Captain Jno. W. Collins, R.C.S., engineer-in-chief, who also has charge of the electric light, sanitary and steam heating systems, and the inspection of all material.

A triple expansion engine designed to develop 1,200



OUTLINE OF MACHINE SPACES U. S. SINGLE SCREW REVENUE CUTTER.—PLAN AND ELEVATION.



PLANS OF THE NEW STEEL SINGLE SCREW REVENUE CUTTER FOR SERVICE ON THE GREAT LAKES.—LENGTH OVER ALL, 178 FT.; BEAM, 30 FT.; DISPLACEMENT, 620 TONS.

I. H. P., at 195 revolutions, with 175 lb. initial pressure, will be fitted. This engine has cylinders 17 in., 27 in. and 43 in. dia., and 24 in. stroke. A piston valve will be fitted to the high pressure cylinder, and double ported slide valves for the other cylinders. All boxes will be fitted with Katzenstein's metallic packing.

Steam will be generated in two Scotch boilers, each with three corrugated furnaces. The total grate surface of each boiler is about 55 sq. ft., and the total heating surface about 1,650 sq. ft. The shells will be 12 ft. dia. and 1 1-8 in. thick, each made up of two plates. The overall length of the boilers is 10 ft. 3 in. The horse-power per square foot of grate surface is expected to be about 11.

The condenser will form a part of the framing of the engine and will contain about 1,350 sq. ft. of cooling surface made up of 793 Muntz metal tubes 5-8 in. outside dia., No. 16 B. W. G.

The air pump will be an independent single-acting twin air pump secured directly to the condenser. It will have two steam cylinders, each 7 1-2 in. dia., two air cylinders, each 16 1-2 in. dia., stroke being 10 in.

The circulating pump will be of the centrifugal type, having 8 in. suction and discharge, and directly connected to a 7 in. by 7 in. vertical engine. The pump will be connected to the sea by two injection valves, and to the bilge by a bilge injection and a Macomb strainer.

A feed water heater is to be provided, having about 120 sq. ft. of surface. This heater will receive the exhausts of the auxiliaries on the outside of the tubes, the feed water passing through from the feed pump to the boiler. The heater will be provided with a combined air and circulating pump, so arranged that when the vessel is not under way, the heater can be used as an auxiliary condenser for such auxiliaries as require to be kept continuously in operation.

The feed pump is to be of the duplex pattern, having steam cylinders 7 1-2 in. dia., water cylinders 4 1-2 in., and a stroke of 8 in.

Besides these auxiliaries, the vessel will be fitted with steam steering gear, steam windlass, fire and flushing pumps, etc., so as to make her thoroughly efficient in every way.

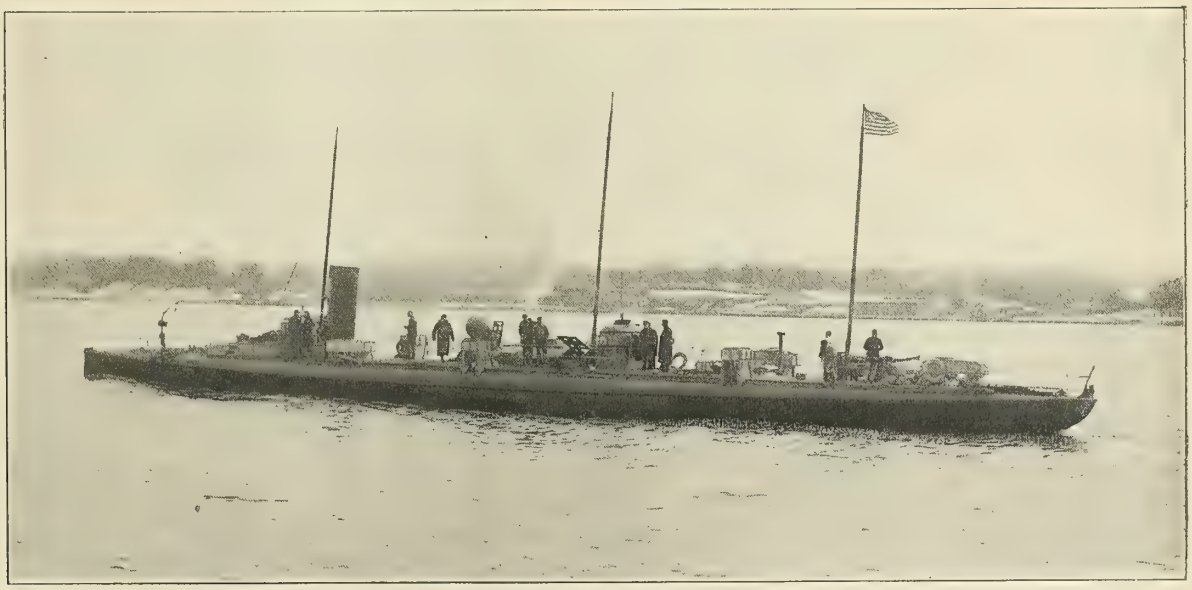
The auxiliaries are to be connected so as to exhaust into the main condenser, the heater, or the receiver at will. By the latter method an economy approaching that of the main engine can be obtained for the auxiliaries, and still all the advantages of separate auxiliaries retained.

The propeller will be a solid cast steel wheel, 8 ft. dia.

In the accompanying drawings the general arrangement of the vessel and her lines are shown; also the arrangement of the machinery spaces.

U. S. Torpedo Boat Somers.

Our illustration shows the German built torpedo boat *Somers* on her way to undergo a speed trial in Long Island Sound. The results of this trial, recently held, as shown by the report of the Board of Inspection, were not entirely satisfactory—a sea speed of only 17 1-2 knots being attained. The Board recommends that the boat be used for harbor defense. It will be recalled that this little vessel was purchased in Europe shortly before the breaking out of the Spanish war, the purchase price being $72,997. An attempt was made to get her across the Atlantic under her own steam, but this failed, and the war breaking out about that time, she was tied up at an English port until its close. After the war the *Somers* was brought across on the deck of a liner. At the Brooklyn Navy Yard her machinery was lifted out and some needed repairs were made. Her dimensions are: Length, 149 ft. 3 in.; beam, 17 ft. 4 in.; displacement, 143 tons. She is fitted with a single screw, driven by quadruple expansion engines of 1,700 rated horse power, and a boiler of the locomotive marine type. Her bunker capacity is 30 tons, and her "estimated" speed was 23 knots.



GERMAN BUILT U. S. TORPEDO BOAT SOMERS STEAMING AT SLOW SPEED.

ENGINEERING IN THE UNITED STATES NAVY—ITS PERSONNEL AND MATERIAL.—III.*

BY ENGINEER-IN-CHIEF GEORGE W. MELVILLE, U. S. N.

In 1885, when Mr. Whitney became Secretary of the Navy, there was inaugurated a period of great activity and progress in the Navy Department, taking what had been done by Secretary Chandler, who started the new navy, and carrying on the work along the lines of logical development. Mr. Whitney's determination was to have ships which should be fully the equals of those in any country, and it was through him that the speaker was called to the position of Engineer-in-Chief of the Navy in 1887, succeeding his life-long friend, Commodore Loring, one of our past presidents, whose reputation as an engineer is too well known to all of you to need any praise from me.

I desire, in this connection, to say that no head of an office has ever been more fortunate in the young men who have been his assistants. No one has ever had the co-operation of abler men, and this has always been rendered with a loyalty and cordiality which deserve all the praise I can give, and I say with perfect frankness that if the progress of naval engineering in our country has been great during the past twelve years, it is due, in a large measure, to the cordial assistance of the talented young men who have worked with me.

I believe it is generally admitted that the machinery of our navy has been in all respects fully abreast of the latest developments, and in many respects we have taken the lead. One of the first things which may be mentioned is the fact that during the period before water tube boilers were used in any navy, and when in some foreign navies there was a great deal of trouble with the shell boilers, due to the effort to get an abnormally large amount of work out of them, we had no such trouble. We believed in the principle of

*President's address (1899) at New York meeting of American Society of Mechanical Engineers.

never sending a boy to do a man's work, and as a result we never had a boiler incapacitated through leaky tubes, and never lost a trial trip on this account, while failures of this sort were very common things abroad.

One of the first things we did was to establish the use of water tube boilers and light compound engines for our steam launches. Private builders in this country had used water tube boilers, but the results, owing to the type of boiler employed, were not altogether fortunate. We found a boiler which has proved entirely satisfactory, and also developed light machinery which was also sufficiently substantial to stand the comparatively rough handling with which the machinery of small boats must inevitably meet. We are to-day the only navy which uses water tube boilers exclusively in its small boats. When we started, the effort was made to save as much water as possible, and small blowers, run at a high speed, were used for draught, but the inevitable hum caused so many objections to be entered by officers of high rank that we were driven to the use of the steam jet. It was, of course, important that the most economical form of jet should be used, but when we came to determine this question we found that there were absolutely no reliable data in existence. As a result, we carried out a valuable series of experiments at the New York Navy Yard, and found an exceedingly simple form of jet, which was also very economical, giving us a fairly high rate of combustion for a comparatively small expenditure of steam.

It was evident to us that with the prevailing tendency toward continual increase of speed and power, with the accompanying increase of steam pressure, the shell boiler would at some near date have to be superseded by the much lighter water tube boiler, and we therefore invited a competition among the various manufacturers of water tube boilers, with a view to determining the one which, all things considered, would be best adapted to naval uses. Although this competition occurred about ten years ago, you are doubtless familiar with the circumstances, and that, as a result, we installed about 5,000 horse-power of Ward boilers in the coast defense vessel *Monterey*, this being at the time, and for several years, the largest installation of water tube boilers in any naval vessel. I am glad to say that these boilers have always given satisfaction, and are still in use. At this same time water tube boilers of a different type were installed on one of our torpedo boats, and we have never used any other than water tube boilers on any of the numerous torpedo vessels which have been built since.

It would have been an easy matter, and it would have brought temporary praise to the Engineer-in Chief, if, after the successful trial of the *Monterey*, we had at once launched out into the use of water tube boilers for all our vessels; but we felt that there had not been sufficient experience in their use to warrant us in making such an experiment in our first seagoing armorclads, and consequently, for a number of years, and even after foreign navies had begun to use water tube boilers extensively, we continued to use the shell boilers in our large vessels. Two years ago, when I felt that there had been sufficient experience to warrant us in the final adoption of water tube boilers, I recommended in my annual report to the Secretary of the Navy that we should definitely adopt water tube boilers for all classes of vessels. For reasons altogether apart from the machinery, we were not at first successful in securing water tube boilers in the department's own designs in spite of my urgent recommendation, but the firms which tendered on the government's designs also offered to guarantee higher speeds if they were allowed to use water tube boilers and more powerful machinery in hulls of their own design. This I had advocated very strongly, and both the technical and daily press of the country had supported this position very heartily, believing that it would be a woeful mistake for our country to build sixteen-knot battleships when the rest of the world were building ones to make eighteen knots, and when by the use of water tube boilers we could so readily do it. I am glad to say that the department accepte the builders' offer, thus definitely adopting water tube boilers and securing the eighteen-knot battleships for which I had worked so hard. At the present time all our new designs include water tube boilers exclusively.

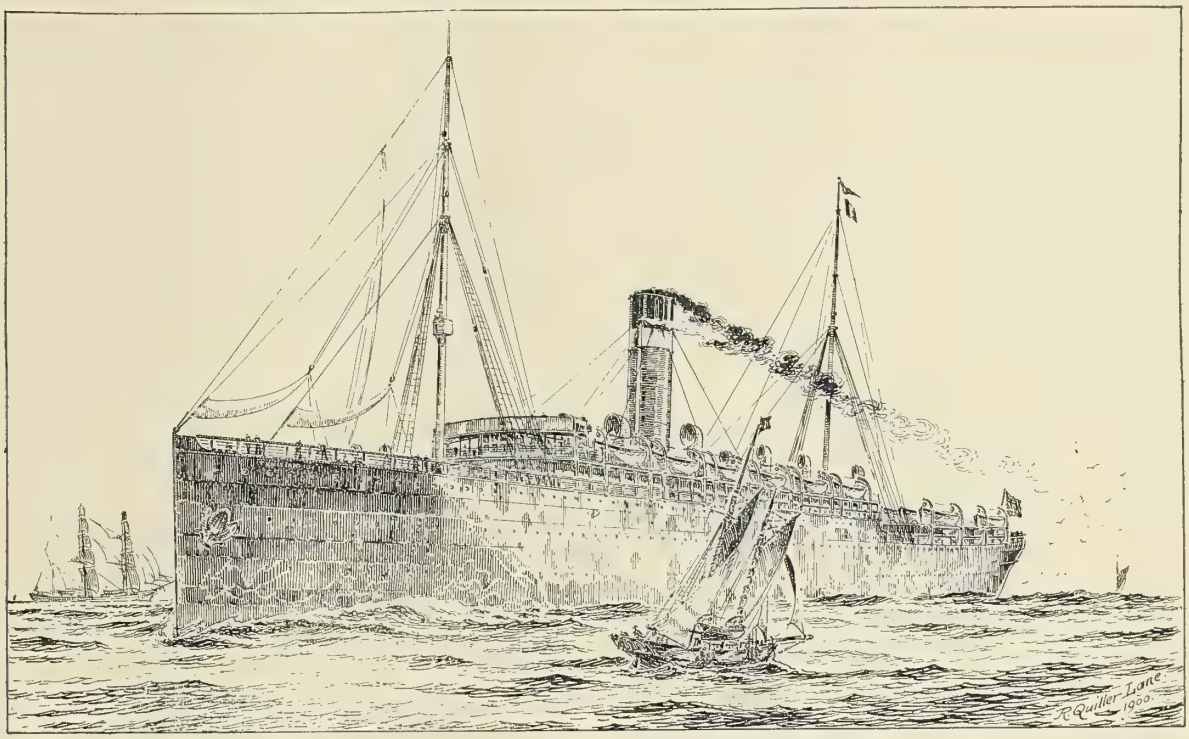
One of the notable improvements in design which we introduced for large vessels was the use of triple instead of twin screws. We were not the originators of this method, as small vessels in both France and Italy had demonstrated its success, and both France and Germany were building vessels of about 12,000 horse-power with this system of propulsion. When it came to the design of the *Columbia*, the first of our commerce destroyers, with 21,000 horse-power, I was satisfied, after careful study of the problem, that we would need to use triple screws to attain success. At the beginning I did not anticipate an economy in propulsion, and the adoption of triple screws was for structural reasons; but when the *Columbia's* trial occurred we found that there was a material increase in the propulsive efficiency. When the *Minneapolis* was tried, shortly afterward, with the same system of machinery, this fact of greater economy was again established, so that we now feel that triple screws are justified not only for numerous other reasons, but on the ground of economy. This arrangement of propellers has become very popular in a number of foreign navies which have followed it out on a considerable scale, and have built all their large vessels with triple screws. It is probable that we shall do the same thing in our larger ships of the new programme.

During our late war with Spain we developed and utilized two engineering schemes which had never previously been tried in actual service—a repair ship and a distilling ship. The former is one phase of the modern method of treating large work by taking the tool to the work instead of bringing the work to the tool. The *Vulcan* was the equal of anything except a very large repair yard, and after the battle of Santiago she was almost invaluable in the much needed general overhaul of all the ships. Besides an admirable outfit of machine tools and engineering stores, the *Vulcan* was specially notable for using the first cupola ever installed on board ship. The distilling ship was fitted with a four-unit triple-effect distilling apparatus capable of furnishing 50,000 gallons of fresh water per diem after use for some time with an economy of over

twenty pounds of water per pound of coal burned under the boilers. With clean coils the *Iris* actually furnished over 100,000 gallons per diem. The bunker capacity is 3,000 tons of coal, thus giving a potential capacity of distilled water of 60,000 tons, or as much as twelve of the largest tank steamers. The advantages of a distilling ship over a "tanker" are very numerous and obvious.

Allan Liner Tunisian.

A large liner for transatlantic service was recently put into the water at the yard of Alexander Stephen & Sons, on the Clyde. This was the S. S. *Tunisian*, 10,200 gross tons, built for the Canadian trade of the Allan line. She is of the money earning, intermediate type, with large passenger accommodation and freight capacity and moderate speed. In dimensions the *Tunisian* measures: Length over all, 520 ft.; beam, 59 ft.; depth, 43 ft. In the accompanying sketch the artist has depicted the new liner at sea, and it will be readily conceded that she presents a noble appearance. There will be accommodation for 200 first-class passengers on the upper bridge deck, 250 second cabin, on the after part of the bridge and on the upper deck amidships, and a considerable number of steerage passengers on the upper deck aft, the latter being berthed mostly in separate rooms. The main saloon occupies the forward end of the bridge deck, being well lighted from three sides and also from a handsome cupola. Most of the first-class cabins are located in a spacious deck house on the upper bridge deck, and on this deck are also the music room and smoking room, these latter rooms occupying the ends. She will have twin screws and triple expansion engines.



NEW S. S. TUNISIAN, 10,200 GROSS TONS, FOR ALLAN LINE IN TRANSATLANTIC TRADE.

FOREIGN NAVAL DEVELOPMENT AND THE EFFECT THEREON OF THE RECENT WAR WITH SPAIN—I.*

BY LIEUTENANT COMMANDER GEORGE H. PETERS, U. S. N.

The purpose of this paper is to show the trend of foreign naval opinion and development, as represented in the professional press and other publications, on subjects of current interest. These foreign views and tendencies are given as being worthy of consideration, but not as being necessarily applicable to our own service.

INCREASE OF NAVAL STRENGTH.

In considering the principal foreign navies with a view of noting recent tendencies of development, the most striking feature which presents itself is the marked effort now making by the important maritime powers to increase their naval strength. Never before, except, perhaps, spasmodically during a naval war, has such endeavor been more vigorous or more general. Whether recognition of this be accorded willingly or unwillingly, it must be reckoned with. The importance of sea power is clearly perceived, and naval shipbuilding programmes grow more extensive and more elaborate.

TYPES OF SHIPS.

In the apportionment of new tonnage abroad the large share set apart for battleships, notwithstanding their great cost, shows that responsible foreign opinion regards them as constituting the real fighting strength upon which reliance must be placed to win naval battles. This view was held long before the Spanish ar-

* From Notes on Naval Progress, issued by U. S. Office of Naval Intelligence, Washington, D. C.

mored cruisers were destroyed at Santiago, but it now meets with general acceptance, and the assertion that the building of battleships is a wasteful use of money and resources is seldom heard. In France and in Italy, for special reasons, the armored cruiser is still held in relatively high esteem, and in the French press the claim has been persistently urged that the battleship will be deprived of its value by the submarine boat; but following this comes a recent request by the Minister of Marine for authority to lay down additional battleships for the French navy.

As battleships are intended to have the greatest possible fire energy, with the best protection attainable, their gun fire must be the maximum which their displacement will permit; and the latest foreign expert opinion is practically unanimous that their armor must not only protect the water line and the gun positions, but that the hull and the personnel must be effectively sheltered.

The typical features of the battleship, maximum offensive and defensive power, are not dependent on circumstances, but are ready at all times. Speed varies with conditions of service, and for battleships is regarded as a secondary consideration, although a very important one. The anxiety which the monitors caused Admiral Sampson has impressed anew upon foreign observers the need of strategic mobility. Other things being equal, the more efficient of two fleets of battleships will be the one whose slowest ship is faster than the slowest ship of the enemy. The aim abroad now is to have the battle fleet composed of ships having great offensive power and the best protection obtainable, with a minimum speed of not less than fifteen knots. While some of the units may be capable of eighteen knots, there should be none that cannot be depended on for tactical evolutions at fifteen knots speed. To attain this obsolete vessels must be replaced or modernized in accordance with the latest developments in engineering.

Next in importance to the battleships is the armored cruiser, which forms a prominent feature of the latest foreign shipbuilding programmes. Vessels of this type have primarily high speed and great coal endurance. They are usually of large size and are given as much protection and as intense fire energy as practicable, but these qualities are secondary, while they may be used to supplement the fleet of battleships, if necessary, in maintaining command of the sea at strategic points, and are most useful adjuncts of such a fleet; it is held by many foreign writers that they have also a distinct field of operations. While these operations will not be decisive in their results in a war between great naval powers, yet the sudden opportune arrival of an armored cruiser, or of several of them, at well-chosen points, may have a great influence on the war. Their size, speed and armament enable them to engage successfully any except battleships. They are regarded as the most effective type for carrying on a cruiser war of depredation.

It was formerly held by some writers that armored cruisers would prove superior to battleships, owing to their greater speed, but since the close of the war with Spain such claims are seldom heard.

It is worthy of note, however, that with the effort to give increased speed to battleships and better protection to armored cruisers these two types tend to approximate.

Armored coast defense vessels appear to be practically ignored in present foreign programmes for the increase of modern fleets. There are two reasons for this, the first being the general belief that naval force will be mainly employed in sea contests, rather than in merely defending home shores against attacks by an enemy. The second reason for not building new armored coast defense vessels is that in the European navies it is felt that they already have a sufficient number of vessels of this type, and that future needs will be supplied by taking from the active armored fleet the older vessels as these are replaced from time to time by others of later type. In the British navy, in pursuance of this plan, the obsolete ships formerly stationed in home waters as coast guard and port guard ships have been succeeded by vessels which, though old, are still efficient. In Germany the same end is attained by the rule assigning a definite length of service—twenty-five years—to a battleship as such, upon the expiration of which she must be replaced by a new ship and transferred to the list of coast defense ships. The monitor type is regarded abroad as having been thoroughly discredited by the experience of the war.

The need of making liberal provision for the building of cruisers is fully recognized abroad, and this has simply been emphasized by the recent war. Their essential qualities are speed, coal endurance, and means of coaling rapidly. With these characteristics their usefulness will be so great that no admiral will be likely to feel that he has enough of them. It is generally accepted that this is as true of cruisers to-day as it was of fast frigates in the days of Nelson. Whatever method of scouting or of search be adopted, the finding of a fleet at sea must always remain a very difficult problem, in view of the obstacles of limited horizon, unfavorable weather, fog and darkness.

Very small cruisers and light draft gunboats continue to be provided, their number and varying qualities depending upon the special needs of the different navies for cruising or for minor shoal water operations.

With regard to torpedo boats and destroyers, foreign naval opinion is practically unanimous that the war has thrown no new light on the question of their value when used for the purposes for which they are intended. Navies which held them in high esteem before still continue to do so. Their vulnerability has long been recognized, as has the fact that they are peculiarly a weapon of opportunity, requiring for their successful use favorable conditions, which may or may not be present at a given time and place. Their usefulness in the training of young officers is universally conceded. Organized as instructional flotillas or as a part of the mobile defense of ports, exercises with them are continuous and systematic, and are not confined to the period of the annual manœuvres. Torpedo boat destroyers, simply larger torpedo boats with increased gun armament and better sea-going qualities, are coming more and more into favor as the best type. In Germany it has been decided to build no more small torpedo boats. New ones are to be of the destroyer class, and will be as large as the former division boats.

Foreign torpedo officers believe that while torpedo

boats are an accessory upon which dependence cannot always be placed, yet their presence will have great moral effect, and that they are capable of very effective work. In foreign squadron manœuvres night attacks by torpedo boats have very frequently been judged to be successful, and it is urged that prior to the late war the number and tonnage of vessels sunk by torpedoes exceeded those destroyed by gun fire.

Submarine boats have not received much attention abroad of late, except in France, where a number of them of new type have been authorized.

While it has not yet received embodiment to any extent in new construction, foreign comment shows a clear apprehension of the need of a sufficient number of vessels for supply and auxiliary service, having the speed and other qualities requisite for efficiency. These are seen to include colliers fitted to give coal rapidly at sea, distilling ships to replenish fresh water for boilers, repair ships to obviate withdrawal for any except for large repairs, ammunition vessels to make good the enormous expenditure of the rapid-fire guns, provision ships with refrigerating plants, telegraph cable steamers, fitted also for laying out submarine mines and for countermining operations, powerful tugs with mine-laying as well as wrecking facilities, and hospital ships.

ARMAMENT.

The view that a rapid-fire battery of moderate caliber, giving the greatest possible fire energy, should constitute the main reliance of battleships has been confirmed in the minds of foreign officers by the war with Spain. In the British navy the 6-in. rapid-fire gun continues in favor for this purpose. In all progressive navies rapid-firing guns are displacing those of older type. While a large allowance of guns of the smaller calibers is provided for special purposes, yet it is claimed by many experts abroad that in view of the abolition and removal of wood from ships, now in progress everywhere, these smaller guns will never again have the same relative importance that they had at Santiago, where it is noted that engines and boilers were not injured, steering gear was not damaged, and very few guns were dismounted. The unarmored portions of the sides of the Spanish ships simply served to explode the small projectiles, which killed and demoralized men and started uncontrollable fires. But better protection will hereafter be given, and rapid-fire guns of medium caliber will, it is claimed, become the crew-destroying weapon.

It is generally believed that future battleships will not carry any guns of larger caliber than the 12-in., and by many foreign officers this is held to be excessive. It is claimed that such guns being accessory in their nature, their fire efficiency is not at all proportionate to the sacrifices which they require. An immediate effect of the war was to reduce the caliber of the heaviest guns of the new German battleships to 9.45 in.

It is accepted that the armament of cruisers, whether armored or not, should be composed essentially if not entirely of rapid-fire guns.

Nearly all navies are endeavoring to accelerate their gun fire by improvements in mechanism and by the use of metal cartridge cases for all but the largest guns. The question of the best method of supplying ammunition, especially to meet the requirements of rapid-fire guns, is receiving earnest study abroad.

As an adjunct to the battery, various ingenious appliances, optic or electric, are in use abroad to communicate ranges and instructions to the guns. It is recognized that a hostile shell may paralyze this service, but the object will have been gained if superiority of gun fire can be achieved at the beginning of the battle.

Smokeless powder has long been considered abroad to be absolutely essential, and our recent experience has demonstrated the fact most fully. Such powder should be stable, practically without visible products of combustion, innoxious to the crew in action, and non-injurious to the bore of the gun, besides giving the requisite initial velocity. Foreign experience has shown that these qualities are difficult to obtain in satisfactory combination.

There is universal agreement abroad in the opinion that no provision should be made for the use of torpedoes by battleships and cruisers, except in underwater tubes. On this point the experience of the naval battle of Santiago has only strengthened and made more general a view which has been gathering force for several years past; a view entirely independent of any consideration of the value of the torpedo in its proper sphere. Many progressive torpedo officers, as well as others, now hold that armament with this weapon should be restricted to torpedo boats, and good arguments are offered for its abolition from cruisers and battleships. But conservatism still keeps a few on board, and new designs for battleships in the desire for a maximum of offensive and defensive power retain submerged tubes. It is argued that recent improvements practically double the effective range of the torpedo.

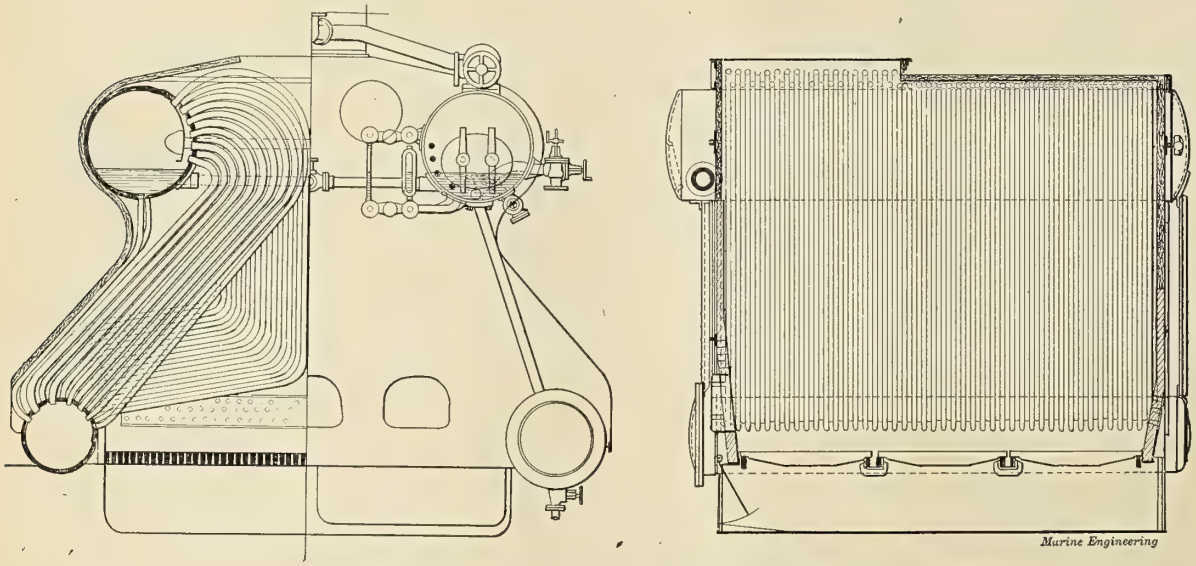
S. S. CHESAPEAKE.—The *Chesapeake*, launched by the Harlan & Hollingsworth Co., Wilmington, Del., March 3, is one of the two vessels which this company is building for the N. Y. & Baltimore Transportation Line of Philadelphia. They are intended to run "outside" between New York and Baltimore on what is familiarly known as the Shriver Line. The *Chesapeake* was christened by Miss Olivia Brengle Shriver, daughter of Clarence Shriver, president of the owning company. The dimensions of the vessel are: Length, over all, 219 ft.; between perpendiculars, 205 ft.; beam, moulded, 32 ft.; depth to upper deck at center, 23 ft. 3 in. Her motive power consists of one triple expansion, three crank, surface condensing engine of the open front type, with cylinders 18 in., 28 in., 45 in., and 30 in. stroke, supplied with steam by two Scotch boilers 11 ft. dia. and 10 ft. long. She is built of steel throughout and has two decks and three side ports on each side, and is designed to carry about 900 net tons of cargo. The load speed is about 12 knots. There are no passenger accommodations on her excepting those for the officers and crew, as the steamer is built as a freight carrier only. Her sister ship, the *Manna-Hata*, will be launched in a few weeks.

A contract has been secured by the Harlan & Hollingsworth Co., Wilmington, for the construction of a new steamer, 400 ft. long, for the Mallory Line, trading between New York and Galveston.

COMMERCIAL TYPES OF WATER TUBE BOILERS BUILT IN AMERICA.—IV.

Mosher Water Tube Boiler.

The Mosher water tube boiler is of the small tube variety, with expanded joints, and without any flat or stayed surfaces. It is composed of two upper steam and water drums, one at each side of the boiler, and two lower water drums, one at each side of and mostly above the level of the grate. From front to back of the boiler each pair of drums on either side is connected by rows of curved tubes. At the lower ends these tubes are connected with the upper half of the water drums with expanded ends, while at the upper ends all but two rows on each side enter the steam drums, in the upper inside segment of their circumference, above the water line. The two inner rows of tubes are bent between each other for about three-quarters of the length of the furnace thus forming the furnace crown.. For the remaining one-quarter of the length of the furnace the tubes are staggered, allowing the gases to rise and pass upward and forward among the generating tubes on their way to the stack, which is at the front end or top of the boiler. At the back of the boiler between the upper part of the fire box and the casing a row of tubes, in a plane at right angles to the rows of generating tubes, also connects each pair of drums at each side. These latter tubes form a protecting wall at this point and at the same time are an efficient part of the generating system. At each side of the boiler just inside the casing there is a double row of down flow tubes extending from back to front and connecting the bottoms of the drums on top with the water drums at the bottom. These tubes are of the same diameter as the tubes forming the generating system. They are farthest removed from the action of the gases and are comparatively cool. By the use of these tubes, instead of outside down flow pipes of large diameter, greater compactness is claimed as well as a direct circulation from generating to down flow tubes the entire length of the boiler, the water not having to flow to the ends to start on its return to the bottom. They also prevent loss by radiation from the sides of the boiler. The upper drums are connected below the water level by a horizontal tube of large diameter, so that the entire boiler is a unit so far as water supply is concerned. The grates stop a short distance from both the front and back of the boiler. A fire brick wall is fitted at each end, and is pierced with air holes, the wall at the front having openings also at the fire doors. This protects the casing at each end of the grate, and as the holes have free communication with the ashpit the supply of air over the grate can be easily regulated by suitable dampers. Inside each steam drum a baffle plate is fitted, against which the generating tubes discharge the uprushing mixture of steam and water, the water falling to the bottom of the drum and the steam passing upward to a separator or dry pipe. A branch from the top of each drum enters a T in the front of the boiler which connects with the main steam pipe. Surface and bottom blows are fitted, and all the usual attachments in conformity with first-class modern practice. This boiler has been used extensively where hard service is demanded. The designer has fitted it in a number of fast pleasure boats, such as *Yankee Doodle, Nada, Feiseen, Norwood* and *Ellide*. It has been installed also in several torpedo boats of the U. S. Navy, and has been adopted for several of the new war vessels now under construction. It is built by Charles D. Mosher, 1 Broadway, New York.



FRONT AND SIDE ELEVATIONS OF MOSHER WATER TUBE BOILER.

NEW TIMBER FLOATING DOCK.—Extensive additions to the facilities of the Morse Iron Works and Dry Dock Co., foot of 26th St., Brooklyn, New York, have been arranged for. These will include a new sectional floating dock of sufficient capacity to accommodate the largest vessels afloat. The dock will be constructed of yellow pine lumber and will be 800 ft. long over all. Each section will be 80 ft. long by 120 ft. wide, and the pontoons will be 15 ft. deep. The dock will be equipped with centrifugal pumps, driven by electric motors, and with other up-to-date apparatus.

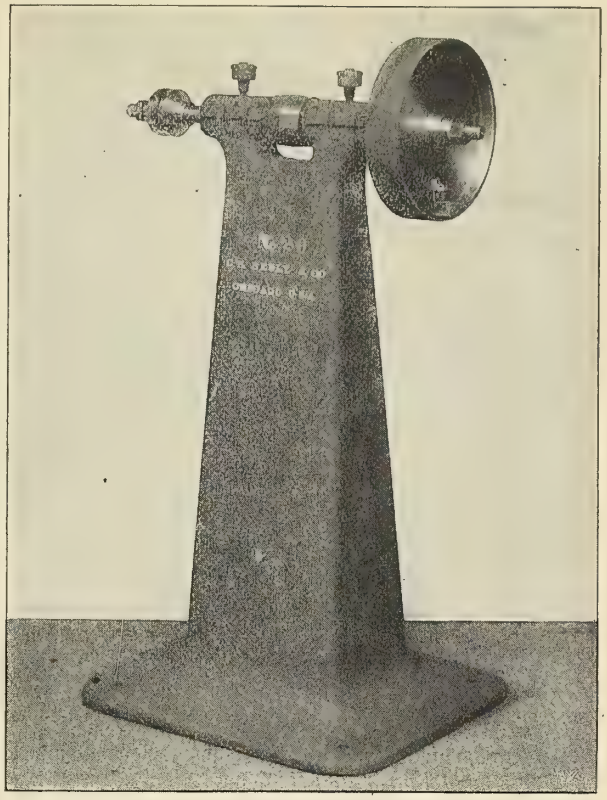
IMPROVED APPARATUS.

Standard Pneumatic Tools.

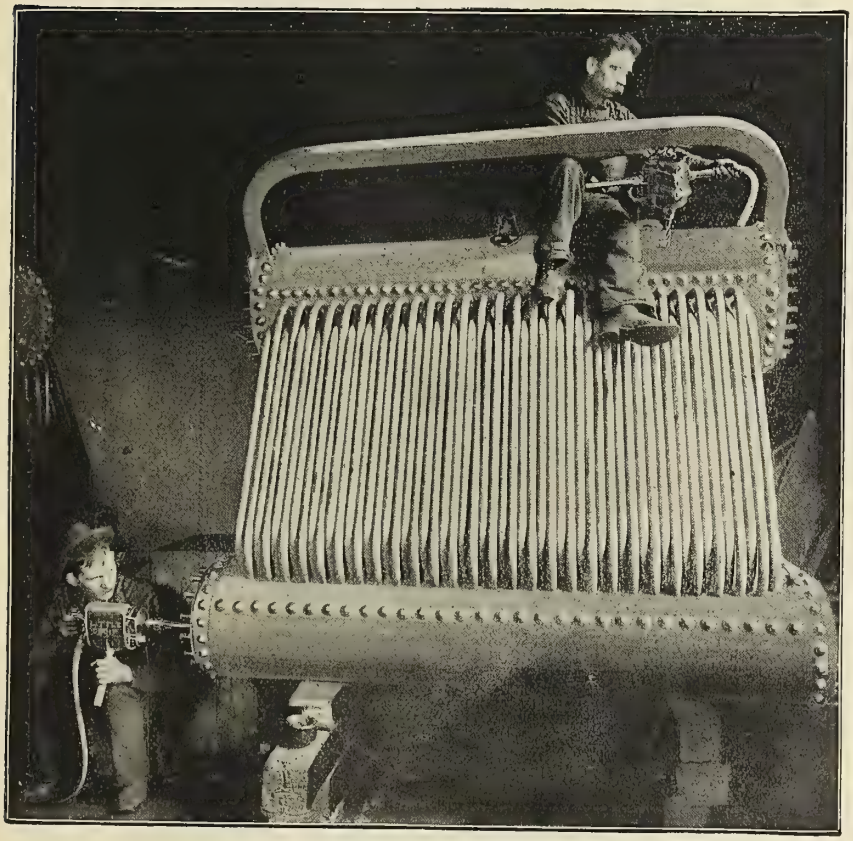
The accompanying illustration shows the "Little Giant" pneumatic reversible flue rolling, reaming and tapping machine, which the Standard Pneumatic Tool Company, of Chicago, has recently placed on the market for various classes of work. It is especially designed to fulfill the requirements of shipbuilders and other affiliated lines, being simple in construction, light in weight and very economical in the consumption of air, and capable of rolling flues up to 4 in. and reaming and tapping up to 1 3-4 in. It is of the piston type, and has double-balanced piston valves which cut off at 5-8 of full stroke. Is made entirely of steel and is geared to run at a high rate of speed, and can be reversed running at full speed by simply turning the grip handle to the right or left, no gears being used to accomplish this change of motion. The makers state that this machine has been given thorough and exhaustive tests in a number of shipyards, and the results have been highly satisfactory, one machine being capable of performing the work of five men. The company offers it to anyone on trial who is desirous of testing his efficiency. The company's address is Marquette Building, Chicago, Ill.

Besly Band Grinder.

We illustrate herewith the Besly band grinding machine. The complete machine consists of pedestal, as shown, countershaft and spindles to hold either one or two emery band polishing wheels. These wheels are made of cast iron. An elastic surface is produced by a felt covering. The emery, or other abrasive material, is a piece of emery cloth which is tightened firmly around the wheel. To reset the wheel, or change the grade of emery, it is necessary only to remove a band and replace it with another, an operation requiring only a minute of time. One of these wheels will take the place and do the work of a large number of polishing wheels. The wheels when used with emery bands are always perfectly balanced and ready for use. This machine is suitable for shops where skilled polishers are not employed. An ordinary shop boy with a little practice can do the work. The diameter of the wheel is 12 in., and the width of face 2 1-2 in. The machine is made in a variety of combinations, so that, in some cases, the band wheel can be used at one end and an ordinary buff or emery wheel at the other. The makers are Chas. H. Besly & Co., 12 North Canal street, Chicago, Ill.



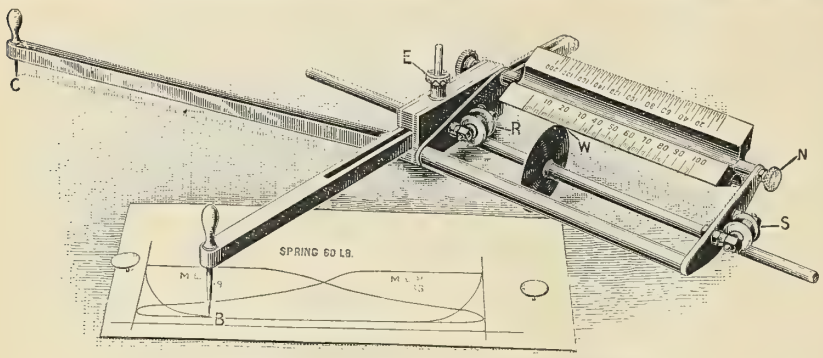
BESLY BAND GRINDER.



LITTLE GIANT PNEUMATIC TOOLS IN USE.

Improved Willis Planimeter.

We show in our illustration the improved Willis planimeter, which is especially designed for the calculation of indicator cards. Users of the former instrument with the glass rod will note that in the new form the glass rod is replaced by a polished steel spindle, which glides beneath the two rollers *R* and *S*. This gives the instrument great smoothness and accuracy of wheel

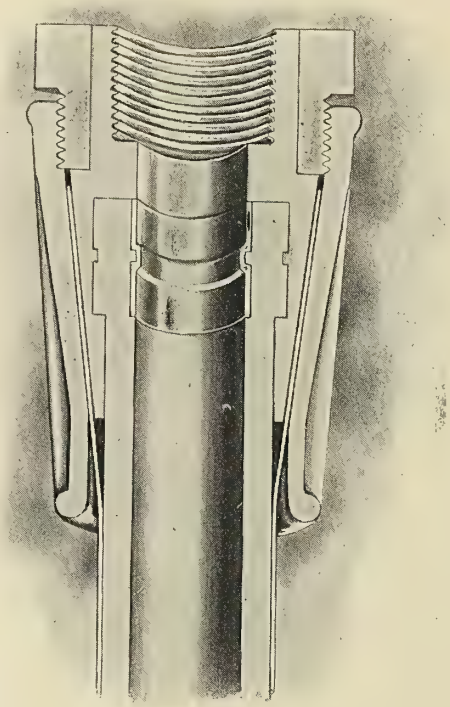


WILLIS PLANIMETER MEASURING INDICATOR DIAGRAMS.

movement, as well as rendering it thoroughly substantial and durable. The depressible pin *E* avoids the trouble of turning the instrument over when setting to card length. The removal of the milled head screws permits the instrument to be taken to pieces and packed readily in a small leather covered case 1 1-2 in. by 3 1-2 in. by 9 1-2 in., which can be carried in the pocket or in an indicator box. The white enameled triangular scale has six graduated edges, and by turning the proper one next the wheel the mean effective pressure can be read directly from the card without calculation. The same scale can be used for setting for boiler pressure, vacuum lines, etc. The instrument is not only serviceable for measuring indicator cards, but, by reason of its various scales and adjustable arm length, will read areas directly in square inches or directly in units particularly suited to draughtsmen and engineers, such as square feet, square yards on different scale drawings, acres on survey maps, etc. There can also be purchased with the instrument a horse-power attachment which permits horse-power to be read directly from indicator cards without calculation of any kind. This latter will be especially appreciated by engineers who have many cards to calculate or to report the horse-power regularly. The instrument is made of polished brass and steel, fully nickeled, and presents a pleasing and attractive appearance. It is manufactured and sold by Jas. L. Robertson & Sons, 204 Fulton street, New York, N. Y.

Climax Armor Hose Coupling.

In these days of extensive use of pneumatic tools in shipyards the item of cost of flexible hose becomes a serious one. Various forms of protective coverings for hose have been tried, with very often unsatisfactory results, due to the imperfect method of attachment to the couplings. The accompanying engraving shows a section of the climax armor hose coupling for use in connection with hose armor consisting of interlaced spiral metallic bands. To apply this coupling to the hose the latter is inserted in the brass sleeve until it butts on the collar below the internal screw. A brass ferrule is then inserted in the end of the hose and expanded, so as to spread both the ferrule and the hose end into the recess cast in the sleeve. Afterward, when the coupling is complete and put in service, it will be seen that the tendency of the air pressure is to make this connection tighter. After the hose end is secured, the armor is pulled up over the tapered end of the sleeve and the outside cover pushed up over it, until it engages the nut at the top. By screwing in this nut the pressure of the outside cover on the metallic armor is increased, so that it is impossible for the armor to work loose. It will be noticed that the lower end of the outside cover is rounded off, so that there is no tendency to kink the hose when a sharp corner is turned near the coupling. The entire coupling is made of the best brass composition, and is practically indestructible. The armor used in connection with this coupling possesses the durability of steel, with the flexibility of India rubber, and prevents bursting, kinking, cutting and mashing of the hose,

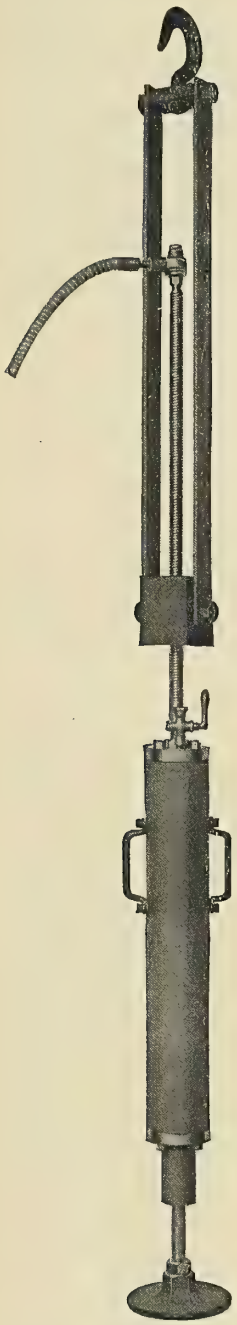


CLIMAX ARMOR HOSE COUPLING.

and will withstand a pressure of 1,000 lb. A large number of these couplings have been put in service with very satisfactory results. They are manufactured by F. G. Street, 538 Temple Court Building, Chicago, Ill.

Keller Pneumatic Rammer.

Hitherto the use of pneumatic tools has been chiefly in ship work and in the machine shop. Now, however, that the advantages of compressed air have come to be better understood its services are being extended to other departments. A valuable time and labor saving aid in the foundry is the pneumatic rammer, the type known as the Keller rammer being here illustrated. This machine is made in three sizes, and is designed for use in heavy loam work and other moulds of large size. One man with the aid of this rammer can do as much work as would formerly have required the services of eight or twelve men by the antiquated hand method. In use the rammer is suspended at a convenient point and is easily moved about over the work by the operator. The rammer piston is controlled by a valve similar to that employed in pneumatic chipping hammers, and the machine is started, stopped and regulated by a special throttle valve which forms a part of it. The advantage in the use of a pneumatic rammer in the foundry lies not only in the rapidity, but in the absolute uniformity of the work, all blows being struck with the same force. This precludes the possibility of hard and soft spots in the mould, with the corresponding defects in the castings, and produces moulds much more compact than is possible by hand labor. The manufacturers will send any of their tools to responsible parties on ten days' trial, subject to approval, and all their tools are guaranteed against cost for repairs for one year. Their address is Philadelphia Pneumatic Tool Co., Stephen Girard Building, Philadelphia, Pa.



KELLER RAMMER.

As the result of experiments with the Marconi system of wireless telegraphy on the North German Lloyd liner *Kaiser Wilhelm der Grosse*, it is probable that this method of communication will be adopted on all the fast ships of that line. Signals were exchanged between the liner and a station 50 miles distant.

LAUNCHES—HOME AND FOREIGN.

Tug William J. Bradley.—The tug *William J Bradley* was launched from the yard of the American Dredging Co., Camden, N. J., March 13. Her dimensions are: Length, 85 ft.; beam, 19 ft. 6 in.; depth, 10 ft. A compound engine 14 in. and 40 in. by 20 in. is fitted. The cost of the tug is about $20,000.

S. Y. Florence.—At the yard of the Herreshoff Mfg. Co., Bristol, R. I., the S. Y. *Florence* was launched March 19. She is a schooner rigged vessel, 110 ft. long, built to the order of A. H. Alker, of New York. She will be fitted with engines constructed by the builders, and is expected to have a cruising speed of about 14 knots.

S. S. Northumeerland.—The passenger and freight S. S. *Northumberland* was launched by the Neafie & Levy Ship & Engine Building Co., Philadelphia, March 3. This vessel was built for the Weems Steamboat Co., of Baltimore, Md., for service on the Chesapeake Bay. She is fitted with a triple expansion engine, with cylinders 18 in., 28 in. and 45 in. dia. and 30 in. stroke, of about 1,100 I. H. P., and two Scotch boilers. About 60 staterooms will be fitted.

Sch. Helen W. Martin.—A 5-masted schooner, the *Helen W Martin*, was launched from the yard of Percy & Small, Bath, Me., last month. Her dimensions are: Length, 280 ft.; beam, 44 ft.; depth, 20 ft.; gross tonnage, 2,265 tons. Oak is the material used in construction of the hull. A steam plant for handling the vessel includes a Hyde steam windlass, wrecking pumps, deck hoisters and donkey boiler. The vessel's lower masts are 118 ft. high and topmasts 54 ft. The standing rigging is steel wire set up with turnbuckles. The vessel is for the coasting or foreign trade.

S.S. Orlando M. Poe.—The lake freight steamer, *Orlando M Poe*, was launched from the Globe yard at Cleveland on March 1. The new vessel, which will be added to the Bessemer fleet, is of these dimensions: Length on keel, 475 ft.; beam, 50 ft.; depth, 29 ft. She is fitted with a single screw and quadruple expansion engines, with cylinders, 26 1-2 in., 37 in., 54 1-2 in. and 80 in. by 42 in. stroke. Steam is supplied by four cylindrical boilers, 13 ft. 4 in. dia. and 12 ft. 3 in. long, built for 200 lb. working pressure. The vessel will carry 6,900 gross tons on 18 ft. draft. She was christened by Miss M. Miner.

S. M. S. Prinz Heinrich.—At Kiel dockyard the German armored cruiser *Prinz Heinrich* was launched March 22. Her dimensions are: Length, 393 ft.; beam, 65 ft.; draft, 24 ft.; displacement, 8,800 tons. Triple expansion engines of 15,000 collective horse power will be fitted for driving the twin screws, and a maximum speed of 20 knots is expected. Guns of the Krupp system will constitute the armament, ranging in number and size from two 9.45-in. downward. Armor carried will be of varying thickness from 5.9 in. on the revolving turrets to 3.9 in. on the gun positions. This vessel is of the same type and much the same size as the U. S. S. *New York*. She was christened by Princess Henry of Prussia.

MARINE ENGINEERING

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Notice to Advertisers.

Copy for changes in advertisements must be in our hands not later than the 20th of the month to insure changes being made in the issue of the month following, and not later than the 15th of the month if corrected proof is to be submitted.

SECRETARY of the Navy John D. Long recently issued a general order creating a board of officers with functions which, in part, are apparently in conflict with those of several of the existing naval bureaus. The order reads as follows:

> General Order No. 544—A General Board is hereby established to be composed of the following officers: The Admiral of the Navy, the Chief of the Bureau of Navigation, the Chief Intelligence Officer and his principal assistant, the President of the Naval War College and his principal assistant, and three other officers of or above the grade of Lieutenant-Commander. Should the principal assistant of the Chief Intelligence Officer, or the principal assistant of the President of the Naval War College, be below the rank of Lieutenant-Commander, an officer or officers of the grade of Lieutenant-Commander or above will be designated to fill such place or places on the board. The purpose of the Department in establishing this board is to insure efficient preparation of the fleet in case of war and for the naval defence of the coast. The Chief of the Bureau of Navigation will be the custodian of the plans of campaign and war preparations. He will indicate to the War College and Intelligence Office the information required from them by the General Board, and in the absence of the Admiral of the Navy he will preside at the meeting of the board and exercise the functions of President of the Board. The board will meet at least once a month, five of its members constituting a quorum, and two of its sessions every year shall extend over a period of not less than one week each, during which time the board shall meet daily.

It will be seen that the naval officers specifically designated by the order include those whose duties are such as to fit them especially for the discussion of questions of strategy and tactics. Subsequent to the publication of the order the three additional officers were increased to five, the selections being Captain Robley D. Evans, Captain Henry C. Taylor, Captain Charles E. Clark, Captain French E. Chadwick and Colonel George C. Reid, U. S. Marine Corps. All the naval officers who are members of the board, therefore, will be combatant officers pure and simple; officers who have always been in the line and who, therefore, have not been transferred thereto. This must indeed be a surprise to those who in advocating the recently enacted personnel bill, saw in that measure a full and free recognition on the part of the old line of the importance of exact engineering knowledge in modern naval operations. Now that line and staff are amalgamated, and are on equal footing as regards rank and privileges, the absence of officers possessing expert engineering knowledge from the board cannot have been occasioned by the spirit of antagonism which existed between the line and the old engineer corps. It must, therefore, be set down to a decision—uninfluenced by any strife—on the part of the powers that be, that the training of the sailor is the best preparation for those to whom is intrusted "the efficient preparation of the fleet in case of war," and for the naval defense of the coast. To many this position will not come as a surprise, for they have looked in vain in past discussions for any admission from the genuine dyed-in-the-wool line that the future naval officer is to be the fighting engineer, but have expected rather that engineering duties afloat would be relegated slowly, though most certainly, to the enlisted man. Now as to the composition of the board: Were its duties only such as would relate to the fighting of ships there might be some grounds for excuse for excluding engineering knowledge from its membership, it being assumed that such knowledge, if necessary, would be obtainable as outside advice. But in this case one of the specific duties of the board is "to insure the efficient preparation of the fleet in case of war," and, manifestly, such duties can only be efficiently performed by a membership which contains a proper balance of engineering science. Without such knowledge the board could only carry on

its duties at second hand, trusting not to personal observation, but to the reports of other and skilled persons. What would have been thought in the old sailing days of a board, with similar duties, which would not have included in its membership a single person who had any intimate acquaintance with sails, or rigging, or spars? About the only explanation that would explain is: "That's the way we do it in the Navy." Can anyone picture the management of the American, the Cunard, or the North German Lloyd lines appointing a board of sea captains to insure the "efficient preparation" of their fleets in case such were needed for service. We rather think that an official styled the superintending engineer would in each instance occupy a large-sized chair near the head of the table in the consultation room. That would be "the way it is done in the merchant marine." Were the duties of such a naval board of a strictly military character, preparation of plans of offense and defense, its existence and composition would be much better understood. To charge it, however, with duties which should now be discharged by existing bureaus, and at the same time to exclude from its membership those who could give it strength and purposefulness, appears to be the best possible way to create confusion and conflict, which would result in disorganization if not disaster in time of emergency. It is apparent that the same influences which secured the appointment of a board of deck officers for the investigation of the *Maine* disaster are still successfully active. For our own part we believe that a condition of "efficient preparation" of our fleets would be better secured by the cultivation of more officers of the Robert W. Milligan type than by the establishment of a score of "general boards."

IN Congress the House Committee has decided upon a naval shipbuilding programme for 1900, which contemplates the construction of two first-class battleships to cost about $3,600,000 each; two first-class armored cruisers to cost about $4,000,000 each; and three protected cruisers to cost about $1,140,000 each. A sum of $12,000,000 is appropriated for the carrying on of construction work on ships already authorized, and additional to this $250,000 for equipment. Progress is made in the long disputed matter of armor plate, the appropriation bill containing a provision authorizing the Secretary of the Navy to contract for armor at the price of $540 a ton. No limitations are imposed as to the total amount of armor to be contracted for at this price, but the expenditure during the coming fiscal year is limited to $4,000,000. By this it is understood that the committee contemplated the letting of contracts only for armor necessary to complete the battleships *Maine, Missouri* and *Ohio* now building. In the bill provision is also made for the construction of two new dry docks, one at the Brooklyn (N. Y.) Navy Yard, and one at the Portsmouth (Va.) Navy Yard, to be of the largest capacity and to cost $1,200,000 each. For continuing the work of rebuilding the Naval Academy at Annapolis $600,000 is appropriated, and a further sum of $2,500,000 for the construction of new cadet's quarters. The question of sheathing ships is left to the discretion of the Secretary of the Navy for settlement, and there is no special provision in the bill for the construction of warships in U. S. navy yards. The provisions of the bill do not in all cases represent the views of the entire committee, and it is not unlikely that there will be prolonged discussion in the House when the bill comes up. In the case of the provision for armor plate the decision was only reached in committee by a majority of two. Meanwhile the Naval Board on Construction, in the expectation that the armor plate dispute would be settled in favor of the Krupp plates, has gone ahead with the discussion of plans for the building of the three battleships and three armored cruisers provided for in the programme of a year ago. Tank experiments with models of the proposed battleships have been in progress for some time at the Washington Navy Yard, and it is reported that these have shown that a considerable addition will have to be made to the displacement of these vessels to carry the armament provided and the machinery necessary to secure the sea speed of 18 knots. New dimensions suggested are: Length, 435 ft.; beam, 75 ft.; with a displacement of 15,000 tons. A preliminary statement for the information of intending bidders is to be issued shortly. The armored cruisers are to be of about 14,500 tons displacement, and are to have a sea speed of 22 knots. Four 8-in. guns in two turrets and a large number of 6-in. rapid firers in broadside will constitute the main batteries. A circular giving the general characteristics of these cruisers will be issued later. The programmes of 1899 and 1900 would give a much needed and effective increase to our Navy.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—BOILERS—VI.

BY DR. WILLIAM FREDERICK DURAND.

§4. BOILER SCALE.

It is well known that sea water contains in solution a certain amount of solid matter, while even ordinary fresh water is not wholly free from similar substances. As long as the water remains in its natural condition these solids remain in solution; but under the change of condition to which the water in a steam boiler is subjected, they are liable, as explained later in detail, to separate out from the water and thus to form scale or sludge according as the circumstances may determine.

The proportion of the solid matter in ordinary sea water is about (by weight) 1 part in 32, or 1-32. This is the same as about 5 oz. per gallon, or 2 lbs. per cu. ft. The solid matter consists chiefly of chloride of sodium or common salt with small quantities of calcium sulphate and carbonate, magnesium sulphate and chloride, with smaller quantities of other substances. An average composition of this solid matter is about as follows:

Chloride of Sodium (common salt)	76 per cent.
Chloride of Magnesium	10 "
Sulphate of Magnesium	6 "
Sulphate of Calcium, (gypsum)	5 "

The remaining 3 per cent. consists of small quantities of other salts with a little organic matter.

The proportion of solid matter in river and lake water is quite variable with the locality, and no representative or average analysis can be given. The amount held in solution may vary from perhaps 10 to 250 parts in 100,000 or from .015 oz. to .30 oz. per gallon, or .1 oz. to 2.5 oz. per cu. ft. It is composed chiefly of the carbonates of calcium and magnesium with smaller quantities of the sulphates of calcium and magnesium, and other substances. In addition to the substances in solution, quantities of sand, mud, organic matter, etc., may be carried in suspension, dependent entirely on the locality and special circumstances.

Boiler scale from sea water is composed chiefly of calcium sulphate or sulphate of lime, as it is commonly called, while that from fresh river or lake water is composed chiefly of calcium carbonate or carbonate of lime as commonly called. With brackish water, as we might expect, the proportions of the two are more nearly the same. Following are analyses of boiler scale by Prof. Lewes which may be considered as typical of the incrustations formed by river water, brackish water, and sea water, respectively.

CONSTITUENTS.	RIVER.	BRACKISH.	SEA.
Calcium Carbonate	75.85	43.65	0.97
Calcium Sulphate	3.68	34.78	85.53
Magnesium Hydrate	2.56	4.34	3.39
Sodium Chloride	0.45	0.56	2 79
Silica	7.66	7.52	1.10
Oxides of Iron and Alumina	2.96	3.44	0.32
Organic Matter	3.64	1.55	trace
Moisture	3.20	4.16	5.90
	100.00	100.00	100.00

It thus appears that scale from river water may be looked on as an impure calcium carbonate, that from sea water as an impure calcium sulphate, while that from brackish water, as we should expect, is a mixture of the two in more nearly equal proportions.

Sodium chloride or common salt is soluble in water until the proportion exceeds some 25 or 30 per cent. This corresponds to a density of 8 or 10 on the usual hydrometer, and is far greater than that reached by the water in marine boilers. This substance therefore gives no trouble so far as helping to form scale is concerned, and the small amount found in analyses of boiler scale is probably due to the shutting in, so to speak, of a small amount of water during the formation of the scale. In discussing the formation of boiler scale for our present purposes, it will be sufficient to refer to the behavior of the salts of calcium and magnesium.

Calcium carbonate ($CaCO_3$) is practically insoluble in water, while calcium bicarbonate (CaC_2O_5) is quite soluble, and it is in this form that the substance exists in solution in water. If now the water is heated to the boiling point carbonic acid (CO_2) is driven away from the bicarbonate, it becomes reduced to the simple carbonate, and being now insoluble it separates out as a more or less powdery deposit. Mixed with other salts, however, especially calcium sulphate or if there is a little sulphuric acid in the water, it may collect on the heating surfaces and form a hard and closely adhering scale. Magnesium bicarbonate is in a similar manner reduced to the simple carbonate, which is insoluble and is then deposited in the same fashion.

Calcium sulphate is soluble in cold water to a slight extent, as found in sea water. As the water is heated, however, or as the density becomes greater, the proportion of sulphate which it can retain in solution becomes less and less. When the temperature rises to from 280° to 290° (corresponding to from 35 to 45 lbs. gauge pressure) the water can no longer retain any of the sulphate in solution, and it is all deposited. It is also entirely deposited, even at a temperature of 212°, if the density rises to 3-32 or above. The other sulphates become likewise insoluble and are completely deposited if the temperature rises to about 350° or over, corresponding to about 120 lbs. gauge pressure. These sulphates of lime and magnesium thus deposited tend to attach themselves to the surfaces within the boiler, and to form a very hard and crystalline scale.

As to the effects of this scale, its presence in a *very thin* layer is often considered beneficial as a protection to the surface of the boiler from corrosive influences. On the other hand, however, it is a much poorer conductor of heat than metal, and its presence on the heating surfaces retards the transmission of heat from the fire through to the water. In the extreme case the heat may be so effectually shut off from the water that it simply becomes banked up, so to speak, in the metal, and in this way the tubes and other heating surfaces may become seriously overheated with resulting damage to the boiler. The scale may also in extreme cases become so collected between the tubes or between the combustion chamber and boiler sheets as to impede the circulation of the water and thus lead to overheating and its dangers as referred to above. In water-tube boilers the accumulation of scale on the inside of the heating tubes is of special danger, as the circulation becomes in such case rapidly obstructed and the danger of overheating and rupture is correspondingly increased. In a similar man-

ner the accumulation of scale in the interior of tubular feed-water heaters rapidly decreases their efficiency as heaters, if no worse results follow due to the burning out of coils, or to the resulting shortness of water in the boilers.

Scale Prevention, Fresh Water—The only sure way of preventing scale is simply to keep it out of the boiler. If the scale forming substances find entrance to the boiler it will be found very difficult to prevent its formation, at least to some extent.

On boats navigating inland waters the jet condenser is still for the most part used, and the feed is ordinarily taken from the condenser, and therefore practically from overboard. In such boilers, therefore, we may expect the formation of the usual fresh water scale, consisting chiefly of calcium carbonate. For the treatment of fresh water scale a great variety of methods have been proposed. In some cases the substances proposed act chemically, in others mechanically. From the great variation in the character of the solid matter contained in fresh water, it can hardly be expected that any one method of treatment or substance will prove equally good in all cases.

If a feed-water heater is used, and is effective in heating the water, it will be found that most of the scale will be deposited in the heater, especially if it is of sufficient size to allow of proper time. In this way the scale may be kept out of the boiler proper. The heater, however, should be so made as to readily admit of cleaning, especially if the water contains any considerable proportion of scale forming salts, otherwise it will soon become choked and ineffective.

Among the various substances which have been recommended for the prevention of fresh water scale the following may be mentioned.

Oak and hemlock bark and other like substances which contain tannic acid are more or less effective in waters containing carbonates of calcium or magnesium. The tannic acid, however, will attack the iron of the boiler and may lead to serious corrosion.

Molasses, cane juice, fruits, distillery slops, vinegar and other like substances containing acetic acid have also been used with success where no sulphates are present. The acetic acid, however, is still more injurious to the iron than the tannic acid, and the organic substances will form a scale with sulphates if they are present.

Sal-ammoniac when used with a feed water containing calcium carbonate brings about an exchange between the two substances as a result of which ammonium carbonate and calcium chloride are formed. The former of these is soluble and quite volatile and passes off mostly with the steam. The latter is quite soluble and thus the deposition of the calcium carbonate is avoided. This operation by itself, however, would result in the gradual accumulation of calcium chloride in the boiler, thus raising the density of the water to a point where ultimately it would begin to deposit. This condition may, of course, be controlled by a suitable use of the blow.

Tannate of soda is well recommended for general use, but with water containing sulphates a small amount of soda-ash should be added.

Among the substances which act mechanically, crude petroleum and kerosene oils are probably the most widely used. The latter may be recommended as the better of the two, as the crude oil will sometimes aid in scale formation. They seem to act best in cases where there are some sulphates present, as in slightly brackish water, or in the waters of certain geographical regions. Kerosene seems to act by preventing the particles of scale from sticking closely together or from tightly adhering to the heating surfaces, so that much of the matter will collect as a sludge in the bottom of the boiler, and that on the heating surfaces will be more easily removed.

In all cases where there is reason to expect the accumulation in the bottom of the boiler of deposits thrown down in a loose or powdery form, the bottom blow should be freely used so as to prevent the accumulation of too great a quantity, or opportunity for its hardening into scale.

In spite of all modes of treatment there will be found some scale on the heating surfaces, and provision must be made for entering the boiler and removing it with appropriate tools as the occasion demands and circumstances permit.

In many of our inland waters the amount of scale forming substances is so small that no special treatment is thought necessary, and little attention is paid to the matter except to remove the accumulation at the periods of regular inspection and overhaul.

ENGINEERS' DICTIONARY.—XXVI.

Lead—The amount by which a valve port is open when the engine is on the center, or piston at the end of the stroke. See Fig. 85, where *AB* on the steam side

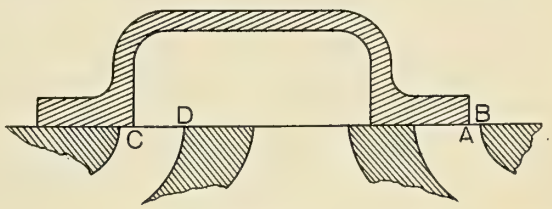


FIG. 85.

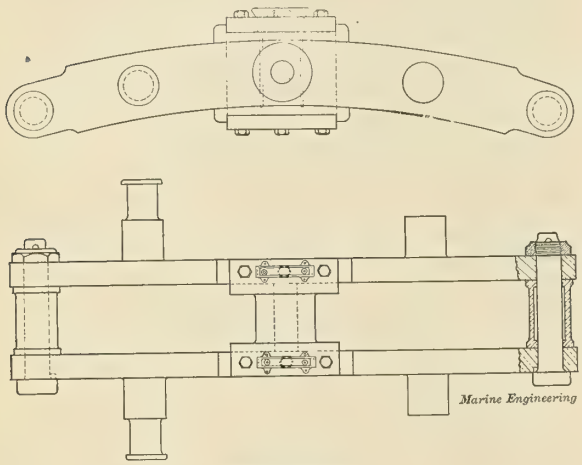
represents the *steam lead* and *CD* on the exhaust side represents the exhaust lead, the engine being supposedly on the center for this position of the valve.

Liner—In general, a piece of metal intended to take the wear of working parts, or to fill in between the parts of a bearing so as to allow of an adjustment. Thus the main cylinder barrels and valve seats are often provided with a working liner. See under *Cylinder*, Fig. 42. Likewise between the two parts of the main pillow blocks or other similar bearings, there is placed one or more metal strips or liners, thus providing for adjustment as the parts of the bearing become worn and require taking up.

Line Up—A term signifying the adjustment of an engine or line of shafting so that all parts shall be in line, or in the same plane, or at right angles to the center line, as may be required for smooth and proper working. Thus when a marine engine is properly *lined up* the shaft bearings from propeller to main pillow-blocks are all accurately in line; the piston-rods all move in the same plane, and the line of motion of each is perpendicular to the axis of the shaft; and similarly for all moving parts.

Link—In its more general sense a link is a rigid moving part of a machine serving to transmit motion from one piece to another. Thus in the mechanism forming a steam engine the connecting rod is a *link*. The rods which connect the end of the air pump lever to the air pump cross-head are *links*, etc.

In its more particular sense the term link usually refers to a part of a valve gear, as in Figs. 86 and 87, showing the Stephenson link. The form commonly met with in modern practice, and as shown in the figure, is known as the double bar link. This consists of a pair of bars curved in the arc of a circle of radius



FIGS. 86 AND 87.

equal to the geometrical length of the eccentric rod; that is, equal to the distance from the center line of the link to the center of the eccentric sheave. These bars are connected at the ends by bolts, as shown, with distance pieces between them. Near the ends are fitted the pins which serve for connecting with the eccentric rods as shown. Another pair of pins is also fitted either at the center or as an extension of the pins at one end, or at some intermediate point. To these are attached a pair of links usually known as *side* or *bridle* rods. These lead to the *rock* or *weigh* shaft, and serve to control the position of the link and thus to vary the point of cut-off, according to the principles which govern the action of this form of valve gear.

Between the two bars of the link is the *link block*. This consists of a central pin, with wing pieces at the ends, the latter being fitted with bearing surfaces for connecting with the bars of the link, and permitting sliding motion between the two. The pin is connected with the lower end of the valve stem by an appropriate bearing, and thus the motion of that part of the link where the block is located is transmitted to the valve in accordance with the mode of operation of this type of gear.

The single bar link consists of a single curved bar, with a slot of corresponding curvature, carrying a block and operating essentially as for the double-bar link.

Link Block—See *Link*.

Link Motion—A general term for an assemblage of links forming a mechanism; or, more particularly, for a Stephenson link valve-gear taken as a whole.

TECHNICAL PUBLICATIONS.

ELECTRIC WIRING. By Cecil P. Poole. First Edition, 1900. Power Publishing Co., New York. Size, 4 1-2 by 6 3-4. Pages, 101. With many diagrams. Leather cover, $1.00.

This book is the only one thus far published in which actually complete data and instructions are given for the laying-out and computation of circuit wires for all classes of service. The scope of the book extends from the simplest motor wiring to the most complex polyphase alternating-current circuits, including three-wire direct-current circuits, etc.

Not only instructions and rules are given, but there are diagrams illustrating these and comprehensive tables, calculated from them. The tables will enable anyone, without technical education, to determine the proper sizes of wire for any class of service, and the arrangement is such that much greater accuracy may be obtained and finer distinctions may be drawn than from the usual form of wiring table. One immensely valuable feature is a set of tables for two-wire and three-wire direct-current circuits and two-wire alternating-current circuits, which enable the user to determine, at a single operation, the sizes of wire to use in both the feeder and the mains of the system, for a given "drop" over all.

Besides the tables and wiring instructions, there are several pages of diagrams showing the various methods now in vogue of connecting up bells, lamps, transformers and motors, and an appendix containing complete formulas for all wiring computations.

An advantage of the book is its most convenient size—practically a pocket-book. It is very well printed and neatly bound in a flexible leather cover. For the engineer who has the laying out of electrical work, as well as for the out and out electrician, the book is without qualification an indispensable assistant.

MARINE ALMANACK, 1900. Edited by *Mittheilungen aus dem Gebiete des Seewesens*. Gerold & Co., publishers, Vienna, Austria. Pocket size. Pages 435. With marginal index, blank sheets for notes and pencil case; and many illustrations. Price, 4 1-2 marks.

The purpose of this little volume is to furnish in condensed form the greatest possible amount of information relating to the navies of the world and their armaments. Prepared fundamentally under the auspices of the Austrian Department of Marine, and for German-speaking peoples, its reputation and field of usefulness have become widely extended as a reliable, compact and convenient source of information on the subjects of which it treats.

Aside from the calender and like information of general interest, the book is divided into four parts.

Part I consists of reduction tables for weights and measures. This covers some 30 pages of closely printed matter, and gives, in most convenient form, conversion tables for all sorts of measures, but chiefly, of course, between the English and metric systems.

In part II is given an abstract of marine international law. This is divided into three parts: that relating to peace, that relating to war, and sea ceremonial. The subject matter is arranged with suitable catch heads, and in condensed and convenient form for reference.

The purpose of the compiler has been to state in the briefest possible way the accepted conventions of international law as they bear on maritime matters, and he is to be congratulated on having produced so complete and convenient a condensation of so wide a subject.

Part III is devoted to tabular data relating to naval ordnance. It covers some 70 pages of matter, and gives in great detail the leading features of the naval ordnance of all maritime powers.

In part IV is presented in tabular form a collection of the leading particulars of the various ships belonging to all naval powers. This covers about 150 pages, and is followed by over 100 pages of line engravings, showing the general appearance of representative ships of the various navies, with diagrammatic representations of the character and distribution of the armor and main battery. Following this and concluding the book is a single alphabetical list of the names of all ships described.

The information relative to ordnance and ships is, of course, similar in character and arrangement to that given in the larger English Brassey, and, while the latter is fuller in some details, the present volume shows how much may be gotten into a volume of pocket size by condensation with suitable abbreviations and arrangement of matter.

The data and measures are, of course, all in the metric system, but the conversion tables above referred to make their change into English measures a comparatively simple matter.

MARINE TECHNICAL DICTIONARY, GERMAN, ITALIAN, FRENCH and ENGLISH Supplement to Vol. I. By Captain Julius Heinz. Published under the editorial direction of *Mittheilungen aus dem Gebiete des Seewesens*, Pola, Austria. Gerold & Co., Vienna, or Dulau & Co., 37 Soho Square, London, W. Size, 6 1-2 by 9 1-2. Pages, 867. No illustrations. Cloth.

About seventeen years ago there appeared the first volume of a nautical-technical dictionary, designed on the broadest and most comprehensive plans. Its author, M. P. E. Dabovich, was occupied some twenty-five years on its compilation, and the first volume was seven years in printing, finally appearing in 1883. It appears that adverse circumstances have until recently prevented the continuation of this work. A few years since, however, the Austrian Minister of Marine ordered the completion of the dictionary, and such progress has been made as to render possible the renewed publication of the work. The first issue is the subject of this notice, and is a supplement to the first volume referred to above. The author of this supplement has adopted the same general methods and lines of work as in the original publication, in order that by the aid of this supplementary volume the part previously published may be brought fully up to date, and made completely representative of the present state of technical marine terminology.

The supplementary volume thus planned contains a double vocabulary of German and Italian words in an alphabetical order, the former in roman and the latter in *italic* letters, to distinguish more readily between them. When the leading word is German it is followed by its equivalent in Italian, French and English in order, and when the leading word is Italian it is followed by its equivalents in German, French and English in order For translation into English the work is, therefore, equivalent to two dictionaries, one Italian into English and one German into English. The terms given are, with few exceptions not described or defined, and when such is the case only for the German or Italian reader. The work is, therefore, a dictionary simply in the sense of a collection of equivalents in the four languages mentioned, and is, therefore, intended for use in translating from one language to another rather than for purposes of description or definition. The field covered by the work includes not only subjects strictly related to marine construction, navigation, naval warfare, etc., but comprises also all related branches of science and art such as electro-technics, astronomy, chemistry, mathematics, etc. In addition to single words or objects briefly described, a great variety of objects requiring long descriptive phrases are included, such, for example, as "Screw generated by a right line making an angle with the axis backward."

As a departure from the usual mode of presentation, the entire subject matter relating to the torpedo is collected in order under that one head, forming a special vocabulary by itself, and similarly for a few other subjects.

While modern marine terminology is thus exhaustively represented in the present work, it is but a supplement to an earlier volume. It is, therefore, not complete in itself, but abounds in references to the original Vol. I. This, unfortunately, will detract much from its use to those who may not have at hand the earlier volume referred to.

A criticism may, perhaps, be also made on many of the words introduced as being quite untechnical and better left to the ordinary dictionary. Among many illustrations mention may be made of the words *obelisk, reference, crisis,* and expressions such as *damage caused by fire* and *to cross a river.*

The translations into English seem in general to have been made with great care and accuracy, while the extent of the work as a whole and its exhaustive presentation of modern marine terminology are such as to place it easily at the head of such technical dictionaries.

An announcement of the courses of instruction in the Graduate School of Marine Engineering and Naval Architecture of Sibley College, Cornell University, has just been issued in the form of a 20-page pamphlet. This gives an exhaustive statement of the entrance requirements, expenses, studies, and facilities of the school, and would be of much value to the intending student. A special feature is the opportunity afforded those interested in the development of either the science or art of marine construction to take special courses quite independent of the requirements for a degree or for graduation. For many who have received their training along practical rather than theoretical lines the facilities offered would be invaluable. Copies of the pamphlet can be had upon application to Sibley College.

By an explosion recently on the English mail steamer *France* at Dieppe, six firemen were killed and four dangerously injured.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—Kindly give a rule to figure out the pitch of a screw propeller. R. F.

A.—Similar inquiries were answered in detail in our issue of March, 1898. There are a few copies of this issue on sale in this office.

Q.—Is there any point on the path of a crank when it comes to rest? FALL RIVER.

A.—In the ordinary type of steam engine the crank revolves continuously, and does not come to rest or stop at any point in the revolution. On the other hand the cross-head and piston do stop or come to rest for an instant, at each end of the stroke.

Q.—How can I tell the leading crank of a compound or triple expansion engine? P. H.

A.—In a compound engine with the cranks at right angles if you were to stand aft of the engine, and look forward, say, you would see the cranks pass any point, say the top center either in the order *high*, *low* or *low*, *high*, with the right angle or quarter circumference between them. If when passing such a point high comes along first, then high leads; if low comes first, then low leads.

In a triple expansion engine with cranks at 120° the cranks will pass by the fixed point in one of two orders. Beginning with the high it will be either *high*, *intermediate*, *low* or *high*, *low*, *intermediate*. In the former the high is said to lead. In the latter the low is sometimes said to lead, since it takes the place of the high in preceding the intermediate.

Q.—Will you please answer the following questions:

(1) What should be the diameters and pitch for two and three bladed propellers for a 25 ft. boat, engine 5 horse-power, 350 revolutions?

(2) By increasing the pitch of a propeller can the diameter be reduced and the same results in speed be obtained?

(3) What would be the difference in diameters of propellers, two and three bladed single, and two and three bladed ones using two and three mounted tandem on the same shaft?

(4) Would as good results in speed be obtained by using two or three propellers in tandem as by the use of one, two and three bladed propeller? C. H. P.

A.—The information given is not sufficient to properly answer the questions, but estimating the remaining data required the results would be as follows:

(1) { For 3-bladed wheel about 21-in. dia. 30-in., pitch.
" 2 " " " 24-in. " 30-in. "

(2) No.

(3) The known results from propellers placed tandem are altogether too limited to make possible the design of such arrangements with any great degree of confidence. It would probably be safe to allow about 20 per cent reduction in diameter for two propellers, and 25 per cent for three, on the same pitch.

(4) The answer to this is connected with that to (3). It is probably possible to obtain practically as good results with two or three propellers tandem as with one, but it would be quite unsafe to count on it without experimental data as a guide in the design.

Q.—Will you please answer the following:

(1) How is the slip of the propeller estimated? For example, knowing the length, beam, draft and model of hull; horse power and revolutions of engines; diameter and pitch of propeller.

(2) How can the diameter and pitch of the propeller be estimated, giving best results for a given horse power and revolutions of engine? V. E. L.

A.—(1) In a case of design the order in which the various items are assumed or computed is usually as follows:

The dimensions, displacement and form of the ship are known.

The speed is given.

By appropriate formulae or methods of comparison the I.H.P. is computed.

Next a slip is assumed or selected, together with the pitch ratio of the propeller.

Then the diameter is found by the use of appropriate formulas or methods of comparison.

Then follow the pitch and revolutions.

Then if the various results are correct, the propeller as designed with the given revolutions and slip will develop the thrust necessary to drive the ship at the given speed, and will absorb the I H P. in doing so. All of these various assumptions and computations thus hang together, and an error or variation in any one will affect all the others. The point is, however, that the slip is one of the quantities which is selected out of hand, and then if the expectations are realized the propeller will operate at that slip, and will drive the ship at the desired speed.

In selecting the values of the slip, we are guided by two considerations (*a*) the greater the slip the greater the thrust developed, and hence the less the required diameter. (*b*) The best efficiency is usually found at not far from 20 to 25 per cent true slip, and hence when practicable values in this neighborhood are usually selected.

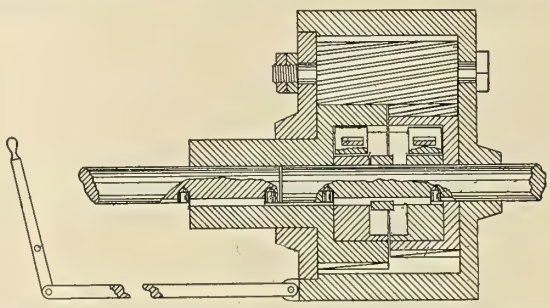
(2) A satisfactory answer to this question would mean a general discussion of propeller design, and this would require more space than can be here devoted to such topics. You are advised to consult some standard work in which the subject is treated.

SELECTED MARINE PATENTS.

(Subscribers are notified that the publication of a patent specification in this column does not indicate editorial commendation or condemnation.)

644,508. Propeller reversing gear. Franklin A. Errington, New York.

The driving-shaft and the propeller-shaft are axially aligned and on the end of the driving shaft is rigidly secured a gear. On the propeller-shalt adjacent this



gear is loosely mounted another gear, a long-faced transmitting-gear meshing with both of these gears. A friction clutch is mounted between the gear on the propeller-shaft and the gear on the driving-shaft.

S. S. PAUILLAC.—Little hope is entertained for the safety of the French Line S. S. *Pauillac*, which recently sailed from New York for Havre, carrying a large number of exhibits for the Paris Exposition. She was last spoken by the S. S. *Germanic* on February 11 last. Among the exhibits on the vessel was a 30 ft. model of the famous Suspension Bridge over the East river at Brooklyn, N. Y., which was complete in construction down to the minutest detail.